A PETITION TO THE STATE OF CALIFORNIA
FISH AND GAME COMMISSION

For action pursuant to Section 670.1, Title 14, California Code of Regulations (CCR) and Sections 2072 and 2073 of the Fish and Game Code relating to listing and delisting endangered and threatened species of plants and animals.

I. SPECIES BEING PETITIONED:

Common Name: **Siskiyou Mountains Salamander**
Scientific Name: ***Plethodon stormi***

II. RECOMMENDED ACTION:

(Check appropriate categories)

a. List ☐ b. Change Status ☐

As Endangered ☐ from _____

As Threatened ☐ to _____

Or Delist ☒

III. AUTHOR OF PETITION:

Name: **California Department of Fish and Game**

Address: **1416 Ninth Street**

Sacramento, CA 95814

Phone Number: **916.653.7667**

I hereby certify that, to the best of my knowledge, all statements made in this petition are true and complete.

Signature: _____ Ryan Broddrick, Director

Date: _____

PETITION TO THE STATE OF CALIFORNIA FISH AND GAME COMMISSION
SUPPORTING INFORMATION FOR

Siskiyou Mountains Salamander ***(Plethodon stormi)***
Common Name **Scientific Name**

EXECUTIVE SUMMARY

The Siskiyou Mountains salamander (*Plethodon stormi*) (SMS) is a relatively recently discovered species, first found in 1963, and described in 1965. In 1971, the species was listed as rare due to the limited number of occupied locations known at that time in California and Oregon. The range of SMS appeared to be very restricted (i.e., 6 square miles) and little was known about its habitat requirements. All rare animal species were automatically designated as threatened when the California Endangered Species Act (CESA) was enacted in 1985. In July 1987 the Department of Fish and Game (Department) prepared a "Five Year Status Report" which recommended that the Threatened classification be retained (California Department of Fish and Game, 1987). Current information on SMS shows the species occupies a greater range and more diverse forest conditions than was known at the time of the status review.

SMS are sedentary, terrestrial salamanders which are lungless and require moist microclimates in order to respire through their skin. These salamanders occupy talus in a wide range of forest types and varied overstory canopy cover. Genetic studies have identified two distinct population segments within the range of SMS.

Population trends have not been evaluated for SMS. Population measurements are problematic because the animals are underground most of the time in talus slopes on steep ground in remote mountainous terrain of Siskiyou County. The number of SMS found at individual sites is highly variable and only a small percentage of the population is likely to be active and accessible at any one time, even during optimal conditions.

Presence/absence surveys are required by the Department in the course of conducting CESA consultations for proposed timber harvesting on private lands; and for the past 10 years under the Survey and Manage provision of the Northwest Forest Plan on Federal lands. These surveys have identified a substantial number of sites where SMS are present and documented a larger range for the species than was previously known. The currently documented range in California covers at least 277 square miles. Within the currently known range there are numerous occupied sites that have been disturbed, either: 1) before SMS was State listed, 2) by activities on Federal lands not regulated by CESA, 3) on private lands which were not believed to be within the range of SMS at the time of the disturbance, or 4) by fire.

Timber harvesting is considered the biggest threat to the species as it is the most

common disturbance within the range of SMS. Fire, road building, quarry development, and recreational developments may also impact the species. Recent data collected on SMS and studies of closely related species indicate that disturbance to habitat may reduce the number of salamanders at an occupied site, but that the species persists and reproduces afterward.

Most (approximately 90%) of the range for this species in California occurs on Federal lands. Approximately 76% of the range is within withdrawn Federal land management types where little or no timber harvesting takes place, while 14% of the range occurs on Federal lands subject to programmed timber harvesting. On private lands, currently no timber harvesting is allowed on SMS habitat, but if allowed, might occur over 10% of the range of SMS except as restricted by other regulatory programs, by private landowner management objectives or by the distribution of commercial timber stands.

In June 2004, a petition was filed for SMS to be emergency listed as threatened or endangered under the Federal Endangered Species Act (ESA) (Greenwald 2004). The petitioners cite the elimination of the Survey and Manage Program and its associated protection of SMS and its habitats as the main reason for filing. The 30-day finding for this petition from the USFWS concluded that there is no imminent threat to the species that would warrant an emergency listing (USDI Fish and Wildlife Service 2004). In making this finding the USFWS explicitly considered the following five risk factors which could lead to Federal listing in the future:

1. Present or threatened destruction, modification, or curtailment of habitat and range.
2. Over utilization for commercial, scientific, or educational purposes.
3. Disease or predation.
4. Inadequacy of existing regulatory mechanisms.
5. Other natural or manmade factors affecting their continued existence.

In June 2001 the Department commenced work to review the status of SMS by assembling occurrence information, coordinating with the U.S. Forest Service, private landowners and researchers. Additional fieldwork and analysis of available information evolved into several draft status reviews. Field data from DFG surveys was provided for review to researcher Dr. Hartwell Welsh in mid-2003 and comments were provided by Dr. Welsh in August of 2003 (Welsh pers. comm.). A draft SMS status review was provided to multiple reviewers in February 2004 and comments were received from Dr. Lowell Diller (2004a pers. comm.); Stuart Farber (2004a pers. comm.); Richard Nauman, Dave Clayton and Dede Olson (2004 pers. comm.); Dr. David Wake (2004a pers. comm.); Dr. Hartwell Welsh and Don Ashton (2004 pers. comm.); Karen West (2004 pers. comm.); and Sam Cuenca (2004 pers. comm.). In late 2004 the Department determined that the status review should be reformulated as a delisting petition, leading to the current proposal.

The Department concludes that SMS is not rare, as it was originally designated, not likely to become endangered in the foreseeable future nor in serious danger of becoming extinct throughout all or a significant portion of its range. Consequently, the Department recommends that SMS be removed from the list of threatened species. Subsequent to such action, the Department proposes to enter into an initial five year program in collaboration with private forest landowners to document and report on the response of SMS to timber operations. At, or before, the conclusion of this effort the Department may elect to extend the work further in time if necessary to document longer term response by SMS to disturbance.

Delisting begins with the submittal of a petition to the Fish and Game Commission (Commission) (Cal. Code Regs., tit. 14, section 670.1, subd. (a); see also Fish & G. Code, sections 2071, 2072, 2072.3.). Following receipt of this petition by the Commission, notice of receipt must be provided in the California Regulatory Notice Register (*Id.*, sections 2072.3, 2073.3; Cal. Code Regs., tit. 14, section 670.1, subds. (b), (c), (d).). Thereafter, the Commission makes a determination as to whether the petitioned action may be warranted and, if such a determination is made, a more detailed status review of the species begins (Fish and Game Code (FGC) sections 2073.3, 2074, 2074.2, 2074.4, 2074.6; Cal. Code Regs., tit. 14, section 670.1, subds. (d), (f).). The status review culminates no more than a year later with the submittal of a report by the Department with a recommendation as to whether the petitioned action is warranted (FGC section 2074.6; Cal. Code Regs., tit. 14, section 670.1, subds. (g), (h).). The Commission entertains that report at a noticed hearing and, along with other input and recommendations from the public, makes a final determination (FGC sections 2075, 2075.5; Cal. Code Regs., tit. 14, section 670.1, subd. (i).). The Commission's findings concerning the petition are published in the Notice Register and, with a determination to delist, a formal rulemaking process under the Administrative Procedure Act (APA) (Gov. Code, section 11340 et seq.) ensues (FGC section 2075.5; Cal. Code Regs., tit. 14, section 670.1, subd. (j).).

A decision by the Commission under the CESA (FGC section 2050 et seq.) to delist SMS would be subject to the California Environmental Quality Act (CEQA) (Pub. Resources Code, § 21000 et seq.). Environmental review required by CEQA for the proposed delisting would occur pursuant to the Commission's certified regulatory program approved by the Secretary for Resources. (See Pub. Resources Code, section 21080.5; Cal. Code Regs., tit. 14, sections 781.5, 15251, subd. (b)). Compliance with that program, including preparation of an environmental document and related public review, will occur during a status review of the species required by CESA if the Commission accepts the petition for further consideration based on a finding the delisting may be warranted. (See FGC sections 2074.2, subd. (a)(2), 2074.6.).

In ideal circumstances, researchers will answer questions about species biology with a high degree of statistical certainty. The hypothetico-deductive scientific method includes the development of hypotheses which are then evaluated by collecting data in an experimental setting. The data are analyzed with statistical methods to determine whether the original hypotheses should be accepted or rejected. A general explanation of this method is made by Pidwirny (2004).

For purposes of CESA, the Department is required to use the best scientific information available when evaluating status of species for listing or delisting petitions (FGC section 2074.6). More often than not, the available information does not answer every question which might be asked about the habitat requirements, distribution or abundance of a species. Because wildlife are difficult to study, conclusions based upon the available information have some degree of uncertainty. Even in these cases, decisions can be made by identifying hypotheses and applying relevant observations, including field data, and predictions from ecological theory (Murphy and Noon, 1991; National Research Council, 1995). The Department used this approach to evaluate the status of SMS. Precise estimates of species abundance have not been made nor are there statistically valid experimental data quantifying suitability of various habitat types for SMS. However, there are easily identifiable hypotheses regarding factors affecting SMS distribution including range, elevation, presence in disturbed habitats, aspect, habitat types and ability to persist and reproduce in disturbed locations. All of these bear on whether the species is threatened and sufficient relevant information is available to evaluate these hypotheses.

1.0 POPULATION TRENDS

Very little data exists characterizing either absolute or relative abundance of this species. SMS are rarely present on or near the surface and even then only a small fraction of the total population is accessible. Established survey methodologies are designed to determine presence, not abundance. Even at sites known to support SMS, subsequent surveys are sometimes unsuccessful in finding animals under conditions believed to be suitable. There is no comprehensive, range-wide population estimate and Department concludes that there is currently no basis to generate such an estimate with available information. However, in this, as in select other instances, the Department believes that sufficient scientific information comprised of extensive data on distribution, information on habitat used by the species, application of ecological principles and an assessment of probable risks can be used to support determinations to either add or remove species from the list of threatened and endangered species.

2.0 RANGE AND DISTRIBUTION

2.1 Early Estimate of Range

SMS were first discovered in a road cut in Oregon by the Oregon Herpetological Society in 1963 (Kesner 1977) and described in 1965 (Highton and Brame 1965). The species is found in Josephine and Jackson counties, in Oregon and northern Siskiyou County, California. When listed as rare[1] by the State of California in 1971, SMS were known only from eight sites in California and seven additional sites in Oregon. At that time the range in California was estimated by the Department to be approximately 15.5 km^2 (6 mi^2).

The Commission kept regulatory files for only four years in the 1970s. The only currently available information pertaining to listing SMS are Commission meeting notes dated April 2 and May 21, 1971[2]. SMS was reclassified on January 1, 1985, when all such animal species previously determined by the Commission to

[1] Section 2051(b) of the FGC then defined "Rare animal" as an animal of a species or subspecies of birds, mammals, fish, amphibian or reptiles that, although not presently threatened with extinction, is in such small numbers throughout its range that it may be endangered if its environment worsens.

[2] Those notes show that the Commission directed the Department to publish a notice amending section 670.5, Title 14, California Administrative Code, adding SMS to the list of rare and endangered species. This action was in accordance with the CESA included in FGC section 2050-2055 and the California Species Preservation Act included in FGC section 900-903. In the Commission meeting notes from May 1971, the proposed list included two “endangered” and six “rare” amphibians (including SMS) and was passed unanimously.

be rare, were designated as “threatened species” in accordance with FGC section 2067.

2.2 Currently Known Range

The current documented range of SMS in California is approximately 718 km^2 (277 mi^2) containing approximately 224 sites where the species is known to occur (Figures 1 and 2)[3]. A newly described related species, the Scott Bar salamander, *Plethodon asupak*, is distributed to the south of SMS. In Oregon, the documented range of SMS is approximately 751 km^2 (290 mi^2) (Mead et al. 2005). This species is distributed between 365 and 1,830 meters (1,200 and 6,000 feet) in elevation (Nauman and Olson 2004). The species is distributed patchily within suitable habitat which is often fragmented across the landscape (USDA, USDI Species Review Panel 2001). Another related species, the Del Norte salamander *Plethodon elongatus*, is distributed to the west of SMS.

The currently accepted survey protocol for detection of SMS was developed under the Survey and Manage provision of the Federal Northwest Forest Plan to determine the presence of SMS on Federally owned and managed lands (Clayton et al. 1999). This protocol contains a narrow sampling window (Farber et al. 2002b). The conditions required under this protocol are very restrictive and sometimes requires effort over several years before enough days meet necessary criteria for completion. High elevation habitats are frequently inaccessible due to snow (Farber et al. 2001; Klug 2003 pers. comm.; Nauman 2004 pers. comm.). Before concluding that a site is not occupied, three surveys, at least ten days apart are required, with a minimum of one survey conducted in the spring. The soil temperature must be greater than 3.5°C (38.3°F) and air temperature must fall between 4 and 20°C (39.2 and 68°F). Relative humidity must be ≥ 65% and the substrate below the first layer of rock must be moist to the touch. Surveys are time-constrained searches and search effort must be a minimum of 4 person-hours per 10 acres of suitable habitat. Habitat is searched by turning over cover objects in a timed area-search method. In addition, freezing temperatures must not have occurred at the site within 48 hours prior to the site visit, except at California sites above 1,372 meters (4,500 feet), where it may freeze lightly (approx. -2°C/28.4°F) the night prior to the survey. However, if multiple site visits are necessary, at least one site visit must meet the low

---

[3] Due to the fact that the field data underlying this shapefile came from different sources, it is possible that some of the observations were duplicated between data sources. To remove duplicate observations, a comparison between field data was made. If an observation occurred within 100 meters of another observation, and if both observations occurred on the same day, by the same person, then the two observations were counted as one. The observation with the most complete attribute information was deemed the actual location. This process may have inadvertently combined two points which were actually different observations, or in some cases, this process may have deemed two observations as unique when in fact they were one and the same.

elevation freezing criterion (i.e., 48 hours prior to the visit).

2.3 Physical Habitats within the Range

SMS occur in the Klamath Mountains province in interior northern California, in areas underlain by metamorphosed marine sediment (chert, marble, slate), metamorphosed sub-marine lava, ultramafic rock (peridotite, serpentine) and granitic rock. The area consists of very steep mountains and mountain valleys (USDA Forest Service 1994a).

Climate conditions in the Klamath Mountains province are characterized by warm, dry summers and cold, moist winters. Average daily air temperatures are about 32°C (90°F) during the summer and near 0°C (32°F) in the winter. Annual precipitation is approximately 50 to 190 cm (20 to 75 inches) and during the winter typically falls as rain below 1,219 m (4,000 feet) and as snow above 1,219 m (4,000 feet) (USDA Forest Service 1994b).

2.4 Biological Conditions within the Range

Variations in elevation, soil, bedrock types, local climate and past disturbance create a wide range of vegetation types within the range of SMS. The Klamath-Siskiyou geographic region is widely recognized as supporting a very high diversity of vertebrate, invertebrate and plant species. Dry vegetation types include Mixed Chaparral, Montane Hardwood-Conifer and Montane Hardwood (Mayer and Laudenslayer 1988). Mesic sites include Klamath Mixed Conifer, Douglas fir and ponderosa pine (Mayer and Laudenslayer 1988). Forest management has been practiced on private forestlands in the area for over 80 years and the resulting landscape supports young, intermediate, and mature coniferous forests along with dry climate hardwood and chaparral habitats (Farber et al. 2001).

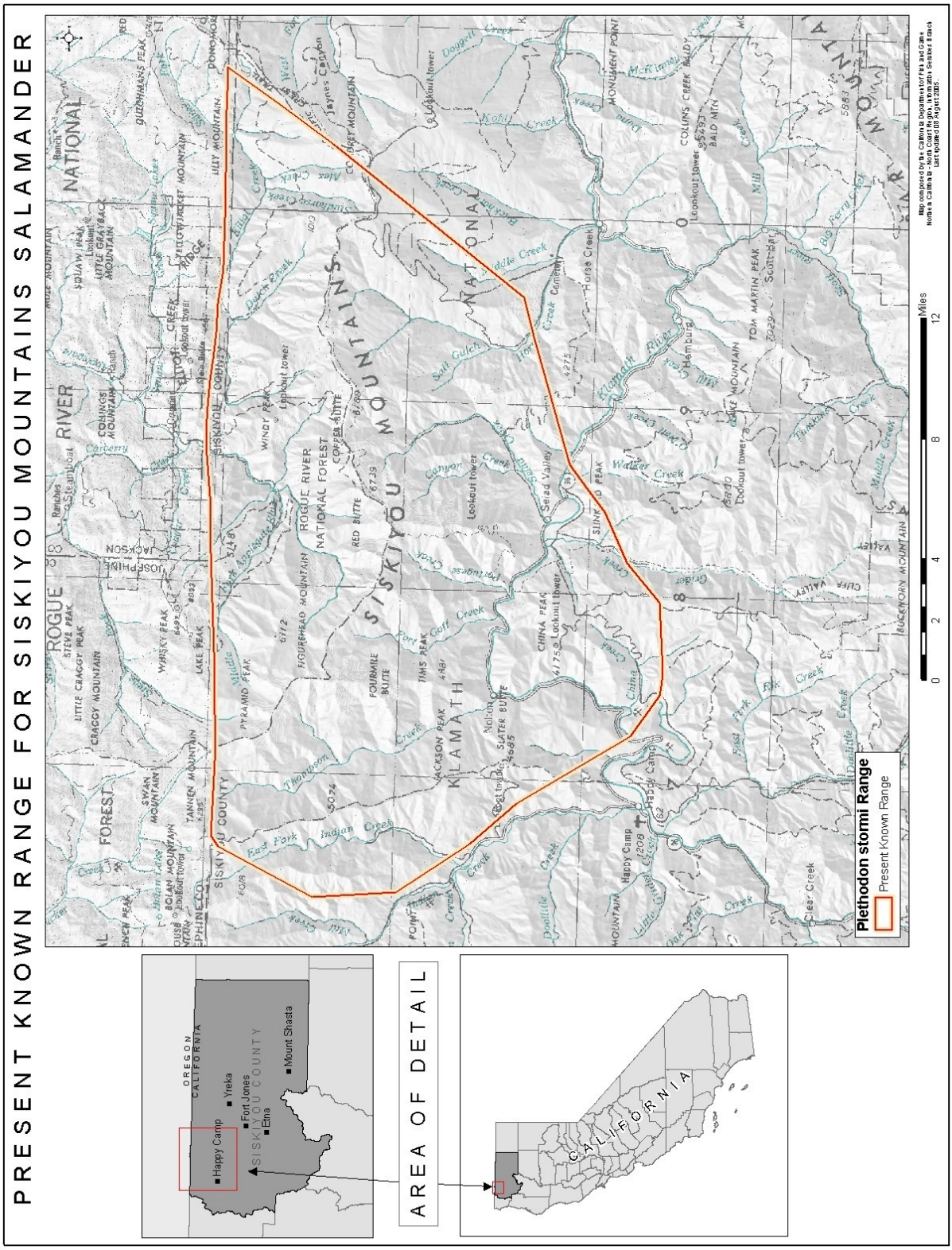
PRESENT KNOWN RANGE FOR SISKIYOU MOUNTAINS SALAMANDER
Plethodon stormi Range
Present Known Range
Miles
0 2 4 8 12
AREA OF DETAIL
OREGON
CALIFORNIA
Happy Camp
Yreka
Fort Jones
Etna
Mount Shasta
SISKIYOU COUNTY
CALIFORNIA
SISKIYOU MOUNTAINS
ROGUE RIVER NATIONAL FOREST
KLAMATH NATIONAL FOREST

FIGURE 1

3.0 ABUNDANCE

Few attempts have been made to determine abundance of SMS. Relative or absolute abundance studies for this species are problematic since the extent to which salamanders are active on the surface depends on variable climatic conditions such as temperature, rainfall and humidity. On a single sampling occasion only 13% (Bailey et al. 2004) of the total plethodontid salamanders in a given sampling area were available for capture near the surface; Taub (1961) found between 2% and 32% in an earlier study. Some studies measure abundance by counting the number (i.e., density) of individuals per square meter (Diller and Wallace 1994; Ollivier et al. 2001). Studies that employ trapping or time-constrained study designs report results as number of individuals found per unit of survey effort (Grialou et al. 2000; Farber et al. 2001).

The number of SMS found at individual sites is highly variable. Depending on micro-site conditions and habitat quality, this species may be locally abundant. As few as zero and as many as 30 individuals per hour have been collected at sites known to support SMS (Clayton 1999). Farber (2001) used a sampling design that described results as the number of individuals per hour of sampling time and reported that the relative abundance at each site ranged from 0.8 to 8.2 salamanders per hour. Nussbaum (1974) reported densities up to 0.53 animals per square meter. More recently, Ollivier et al. (2001) found densities up to 0.27 salamanders per square meter at sites within California.

The known occurrences for SMS are unevenly distributed across their range. Most surveys have been conducted for timber harvest planning or opportunistically. Few large-scale systematic surveys (e.g., Ollivier et al. 2001) have been conducted. The U.S. Forest Service (USFS) pre-disturbance surveys conducted in the northern portion of the range (i.e., north of the Siskiyou Crest) generally find that 3 to14% of any given planning area (generally 10-15,000 acres) is comprised of suitable habitat (USDA, USDI Species Review Panel 2001); i.e., rock outcrops, talus (rock on rock substrate) and forested rocky soils (Clayton 1999). North of the Siskiyou Crest, approximately 30% of the range contains high-quality habitat (USDA, USDI Species Review Panel 2002). Using a stratified random design, Ollivier et al. (2001) reported finding SMS in 64 (27%) of 239 plots sampled in suitable habitat. Abundance at occupied sites can be high (i.e., greater than 20 individuals per hour), but animals are distributed patchily within suitable habitat which is often fragmented across the landscape (USDA, USDI Species Review Panel 2001).

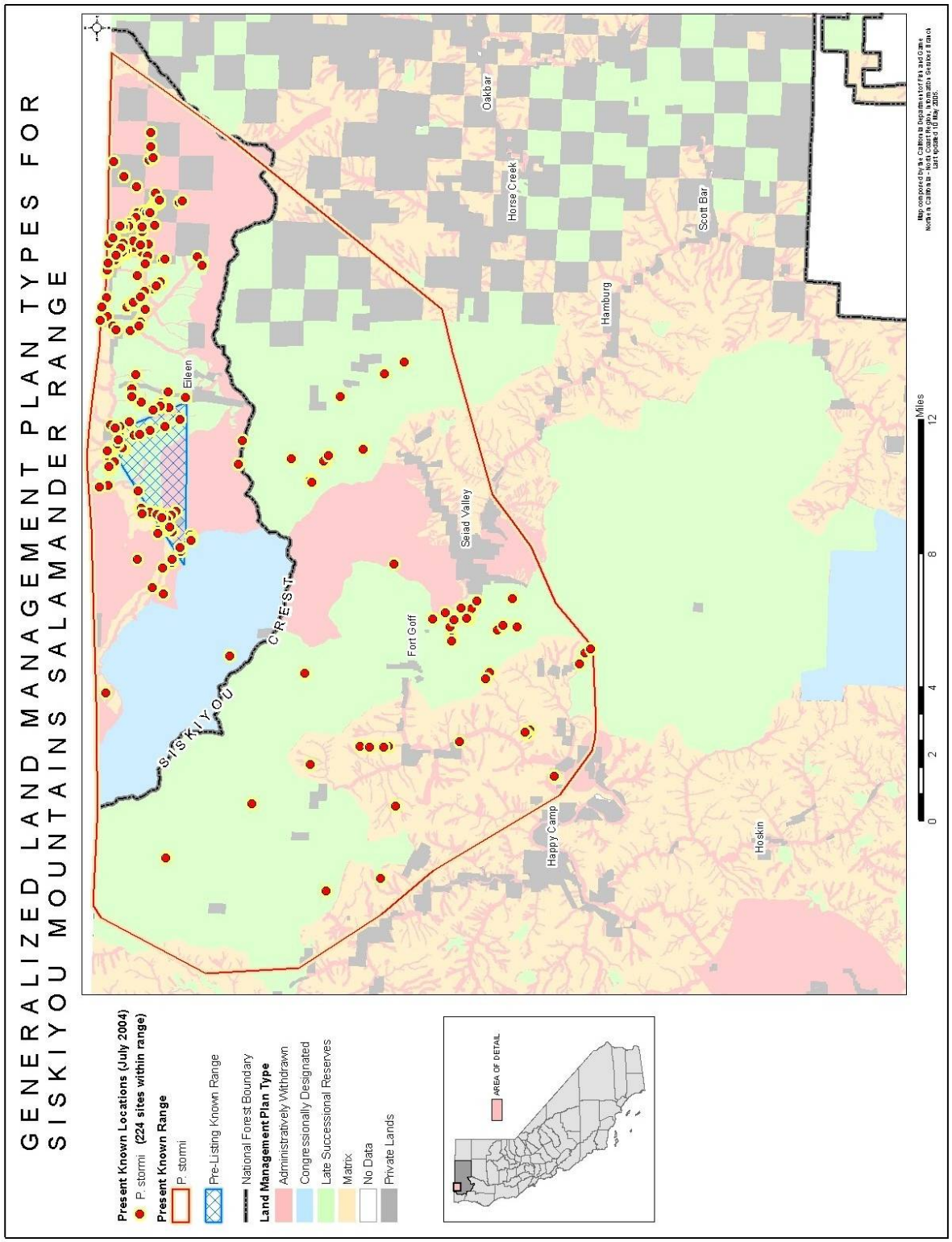
GENERALIZED LAND MANAGEMENT PLAN TYPES FOR
SISKIYOU MOUNTAINS SALAMANDER RANGE
Present Known Locations (July 2004)
P. stormi (224 sites within range)
Present Known Range
P. stormi
Pre-Listing Known Range
National Forest Boundary
Land Management Plan Type
Administratively Withdrawn
Congressionally Designated
Late Successional Reserves
Matrix
No Data
Private Lands
AREA OF DETAIL
SISKIYOU CREST
Eileen
Fort Goff
Seiad Valley
Happy Camp
Hoskin
Hamburg
Horse Creek
Oakbar
Scott Bar
0
2
4
8
12
Miles

FIGURE 2.

The only reported attempt to determine abundance of SMS was by Nussbaum in 1974, when the known range was small relative to the current range. He concluded it was impossible to confidently estimate the carrying capacity of the entire range of SMS and it was nearly impossible to estimate the total abundance of such a small, secretive animal. Making certain assumptions he nevertheless attempted crude estimates of abundance. His major assumption was that it was better to underestimate than to overestimate abundance and he developed a conservative density estimate. The measured density was 0.54 salamanders/ meter^2. Using half the measured density (i.e. 0.27 salamanders/meter^2). Nussbaum estimated a population of 3,055,239 SMS in Oregon and California, with the caveat that actual abundance could be 10 times as high (Nussbaum 1974). This estimate was based upon a range less than half the size known to exist today. The available empirical data does not provide a basis for more precision.

Welsh and Lind (1992) estimated density of the related Del Norte salamander (*P. elongatus*) using mark recapture methods analyzed with two different models[4], based upon the same field data, which produced substantially different results (i.e., 3,200 salamanders/hectare and 9,000 salamanders/hectare). In comparison, the measured density of 0.54 salamanders/ meter^2 by Nussbaum (1974) extrapolates to 5400 salamanders/hectare. One caveat to this information is that discreet patches of continuous suitable habitat are rarely, if ever, as large as a hectare. Further, the particular populations measured by Welsh and Lind (1992) and Nussbaum (1974) may have had higher densities than would be observed on most other sites.

4.0 LIFE HISTORY

SMS is a member of the family Plethodontidae; the lungless salamanders. SMS respire primarily through their skin, are completely terrestrial, and are very sensitive to temperature and moisture regimes. Moist microclimates are essential to survival. SMS move up and down through the substrate as microhabitat conditions change and are usually surface active during the fall, winter and spring rains. Feder (1983) described the physiological limitations that constrain a temperate zone, lungless species like SMS to limited microclimates that provide high relative humidity and cool temperatures. The skin must be moist and permeable for gas exchange to take place. Even in moist microhabitats, plethodontid salamanders may lose water outside underground retreats (Feder 1983). Surface activity for foraging and courtship is restricted to the wettest periods, presumably to limit water loss. Subterranean activity has not been studied (Welsh 2004 pers. comm.).

[4] The models were the Jolly-Seber open population model and the Lincoln-Peterson model.

The closely related Del Norte salamander is a highly sedentary species (Welsh and Lind 1992; Lowe 2001). Using study plots 7.5 meters (24.6 feet) on a side, Welsh and Lind (1992) found the majority of Del Norte salamanders remained within the same plot where they were originally captured. An adult male showed the furthest movement of 36.2 m (119 feet) over a period of 6 months. In a two-year mark-recapture study, Lowe (2001) found that Del Norte salamanders moved an average of 6.7 m/22.0 feet (86% <10 m/32.8 feet, 57% < 5 m/16.4 feet), with the longest movement by an adult male (39.6 m/129.9 feet).

Available data (Nussbaum et al. 1983) for SMS suggest that females lay eggs every other year in the spring. Gravid females may be found in the fall, winter and spring (Nussbaum 1974; Farber 2003 a and b pers. comm.). Although no nests have been found, female SMS likely brood their embryos in nest cavities through the summer deep in talus. Mature females (n=37) had 2 to 18 (average = 9.2) enlarged, white, ovarian eggs (Nussbaum et al. 1983). Eggs apparently hatch in the fall and juveniles may emerge in fall if weather conditions are favorable for surface activity (Farber 2003c pers. comm.). Both sexes are thought to mature at 5 to 6 years of age (Nussbaum 1974).

Plethodontid salamanders are primarily sit-and-wait predators, preying mainly on small invertebrates on the forest floor or beneath cover objects at night. They may feed opportunistically under cover objects during the day. Higher densities of cover objects (rocks, logs, and coarse woody debris) result in higher abundances of plethodontids (Grover 1998). Most foraging is thought to occur at or near the surface of the ground under moist conditions. Primary prey includes spiders, pseudoscorpions, mites, ants, collembolans, and beetles (Nussbaum et al. 1983).

The lives of terrestrial plethodontids consist of long periods of inactivity interspersed with brief periods of activity when thermal and hydric conditions allow. Key physiological specializations (low metabolic rate, relatively large energy stores, and profound resistance to starvation) may enable plethodontids to survive extended periods between irregular feeding bouts. The absence of energetically costly adaptations that might allow more regular activity may be a partial explanation for the extraordinarily low energy requirements of plethodontids (Feder 1983).

SMS are small, slender salamanders (total length = 14.0 cm/5.5 inches) with short limbs (Figure 3). SMS have a modal number of 17 costal grooves and 4 to 5.5 intercostal folds between adpressed limbs (Nussbaum et al. 1983). SMS are chocolate-brown to purplish-brown, dorsally, with variable amounts of light-colored flecks on the head, sides, and limbs. Adults are gray-purple, ventrally. Juveniles are black or very dark brown with flecking, gray ventrally, and commonly display a light brown, tan or copper dorsal stripe (Nussbaum et al. 1983; Leonard et al. 1993; Clayton et al. 1999; Farber et al. 2002a). Salamanders identified as juvenile SMS have been found with dorsal stripes

throughout their range (Farber 2004b pers. comm.; Klug 2003 pers. comm.; California Department of Fish and Game 2003); however, the dorsal stripe is thought to be a characteristic of the Del Norte salamander according to Bury (1998) and Wake (2004b pers. comm.).

4.1 Taxonomic Classification

The *Plethodon elongatus* species group of salamanders includes the Del Norte salamander, SMS and Scott Bar salamander. These species are restricted to the Klamath Province of northern California and southern Oregon (Bury and Pearl 1999). The broad scale patterns of morphological and molecular genetic variation among species in the genus *Plethodon* (Brodie 1970) indicate SMS, Del Norte and Scott Bar salamanders are sister taxa[5] (Mahoney 2001; Mahoney 2004; Mead et al., 2005); meaning they are the immediate descendants of a common ancestral species. The first analysis using nuclear microsatellite loci provided strong support for SMS and Del Norte salamanders as separate species (DeGross 2004). The deviation in morphology from coastal populations of Del Norte salamanders inland to SMS at the interior terminus in the Upper Klamath River (southern side of Siskiyou Mountains) raises the possibility of primary or secondary intergradations (Bury 1998; Mead et al., 2005). Additionally, SMS in northern California are morphologically differentiated from SMS inhabiting the Applegate drainage in Oregon (Bury 1998). The systematics of salamanders are often challenging to describe, and have been the subject of many research investigations (e.g., Wake, D.B. 1997; Wake D.B. and E.L. Jockusch, 2000).

Because there are few well-defined distinguishing morphological characters, the relationship between Del Norte salamanders and SMS has been a matter of contention for some time. They have been alternatively recognized as distinct species (e.g., Nussbaum et al. 1983; Leonard et al. 1993; Bury 1998; Mahoney 2004) or as subspecies of a more inclusive Del Norte salamander (Bury 1973; Stebbins 1985). In the original species description of SMS (Highton and Brame 1965), differences in relative limb length, coloration and number of vomerine teeth were used to differentiate SMS from the Del Norte salamander. The dorsal stripe on juveniles is considered a Del Norte characteristic (Bury 1998; Mahoney 2004; Wake 2004b pers. comm.). However, the stripe has been found on juvenile SMS in northern California and in the Applegate drainage (Farber 2004b pers. comm.; Klug 2003 pers. comm.; California Department of Fish and Game 2003).

[5] A"taxon" is a specific group of organisms, in this case the species *P. stormi.* "Sister" taxa are the closest relatives. In this case the Del Norte salamander, *P. elongatus*.is a sister taxon.

(Photo courtesy of Stu Farber)

Figure 3. Siskiyou Mountains Salamander

Recently, Mead et al. (2005) analyzed salamanders collected southeasterly from Seiad Valley for morphological and genetic differences. Based upon their work the authors identified two alternatives for taxonomic treatment of Plethodontid salamanders near the Scott River. The first alternative would combine two distinctive groups of SMS, salamanders near the Scott River, and Del Norte salamanders into one species, *P. elongatus*, exhibiting extensive genetic and morphological variation. The second alternative is to treat the Scott Bar salamander as a separate species. The authors chose the latter. Upon publication of Mead et al. (2005), the Department solicited the views of several scientists as to the implications of the newly described species upon this petition. Individual responses were received from Dr. Deanna Olson, Dr. David Wake, Mr. David Clayton and Dr. Hartwell Welsh (all 2005 pers. comm.). Drs. Olson and Wake stated that the decision on delisting SMS should not be affected by the description of *P. asupak*, principally because the ranges of the two species are sufficiently distinct. Dr. Olson observed that public lands not subject to timber harvest appear to have lower rates of detection for SMS. Mr. Clayton expressed concerns for *P. asupak* based upon the small documented range, perceived vulnerability to timber harvesting and land management designations within the range. Dr. Welsh states that the recent description of Scott Bar salamander as a new species demonstrates that knowledge regarding plethodontid salamanders in the Klamath region is poor, does not concur with the Department's analysis in the petition and recommends against delisting of SMS.

4.2 Genetic Studies

Several plethodontid species occupy restricted and highly fragmented habitats in Oregon and northern California. The geographical distributions of these plethodontid species suggest restricted gene flow and past habitat fragmentation are important processes in shaping the patterns of divergence and may be important for the conservation of SMS (USDA, USDI Species Review Process 2001; Mead et al. 2005). Movement data on Del Norte salamanders indicate a highly sedentary species (Welsh and Lind 1992; Lowe 2001).

Mitochondrial DNA analyses (Mahoney 2004; Pfrender and Titus 2001; Mead et al. 2005) indicated that Del Norte salamanders, Scott Bar salamanders and SMS have distinct evolutionary lineages. These studies concluded that within the *P. elongatus/stormi/asupak* complex, there are at least four genetically distinct population segments; two SMS, one Del Norte[6], and one *P. sp*. (south of the Klamath River and east of Grider Ridge). Pfrender and Titus (2001) provided four possible scenarios that included:

1) consider them all to be Del Norte salamanders and part of a single highly divided species;

[6] Mahoney (2004) found three distinct population segments within the range of Del Norte salamanders. Mead et al. (in review) and Pfrender and Titus (2001) did not explore the entire range of Del Norte salamanders.

2) include *P. sp*. into SMS;
3) elevate *P. sp.* to a species and include SMS into Del Norte salamanders;
4) elevate *P. sp*. to a species and recognize three distinct species within this complex.

This question is currently resolved by Mead et al. (2005), consistent with the fourth scenario, given the published description of *P. asupak*. Mahoney (2004) found that the morphological boundaries between SMS and Del Norte salamanders were similar to the mitochondrial DNA breaks, leading to support for treating them as sister taxa. Mead et al. (2005) found that within the zone of contact between SMS and Del Norte salamanders, haplotypes[7] did not reveal any genetic mixing (i.e. admixture), indicating that gene flow had not occurred between these groups. However, mitochondrial DNA, inherited only through females, is strongly biased against showing admixture. Dispersal in other salamanders appears to be by males and they will not transmit their mitochondrial DNA, so sharp borders will be apparent even if genetic interchange is taking place (Wake 2004c pers. comm.). These mitochondrial DNA analyses show that *P. asupak* exhibits the highest level of divergence and represents a third major lineage, but only in mitochondrial DNA (Pfrender and Titus 2001; Mahoney 2004; Mead et al. 2005).

Using microsatellite loci, DeGross (2004) found evidence of limited gene flow between SMS and Del Norte salamanders at several contact zone populations in western Siskiyou County. Specimens from populations in drainages that flow into the Klamath River near Seiad Valley showed variable levels of admixture which suggested limited hybridization with Del Norte salamanders. DeGross (2004) also found evidence of two lineages within SMS, but did not look at populations south of the Klamath River and east of Grider Ridge.

Wake (2004a pers. comm.) studied proteins using nuclear genes, which are spread by both males and females, from SMS and Del Norte salamanders. In California, SMS and Del Norte salamanders exchange genes over a relatively large area and some researchers believe *P. elongatus* and *P. stormi* are the same species (Stebbins 1985; Wake 2004a pers. comm.). Alternatively, some believe that if the zone of contact is narrow relative to the range as a whole, it should be two separate species (Wake 2004a pers. comm.).

The third lineage within SMS has been found only with analysis of mitochondrial DNA, and future nuclear gene studies may be conclusive. The third lineage has now been described as a new species, *P. asupak* (Mead et al. 2005).

SMS, Scott Bar and Del Norte salamanders are often difficult to distinguish based upon morphology and recent genetic studies affirm their close relationship. Current studies using several different approaches have detected genetic

[7] A “haplotype” is a combination of alleles for different genes which are located closely together on the same chromosome and which tend to be inherited together.

variations and proposed various descriptive family trees, called “phylogenies” to describe evolutionary relationships (Mahoney 2001; Pfrender and Titus 2001; Mahoney 2004; Mead et al. 2005; Wake 2004a pers. comm.). Genetic studies of SMS have determined that genetic variability in the species is very low (Pfrender and Titus 2001). It is often assumed that low diversity poses a risk to persistence at multiple scales, from an entire ecosystem to an individual species. However, some species with low levels of genetic diversity may have high fitness in their environment (Hedrick 1996) and SMS have persisted for a very long time.

5.0 HABITAT NECESSARY FOR SURVIVAL

Until recently, little was known regarding the environmental requirements and habitat use of SMS. This species was thought to primarily inhabit stabilized talus in old-growth forest stands with northern exposures (Nussbaum 1974; Nussbaum et al. 1983). Early surveys within the Applegate Valley of Oregon and Seiad Valley in northern California were carried out at only a few stand types and at elevations below 1,066 m (3,500 feet) (Highton and Brame 1965; Nussbaum et al. 1983).

The range of SMS is substantially greater than was known when the species was listed as rare in California. SMS occupies a wide range of forest types with a varied range of overstory canopy cover and can be found on all slope aspects (Ollivier et al. 2001; California Department of Fish and Game 2003; West 2004 pers. comm.). SMS is considered a talus or rock substrate obligate and has rarely been found far from talus deposits or fissured rock outcrops (Nussbaum et al. 1983; Herrington 1988; Olson 1999; Ollivier et al. 2001). The presence of talus (rock on rock substrates) and forested rocky substrate may be the most important environmental factor affecting terrestrial salamanders (Bury et al. 1991; Diller and Wallace 1994; Farber et al. 2001; West 2004 pers. comm.). These habitats are common but have a patchy distribution throughout the known range of SMS. Nussbaum et al. (1983) reported that populations of SMS are associated with talus deposits where forest floor litter is thin or absent. However, Stebbins (1985) described habitat for the genus *Plethodon* as talus often covered with leaf litter from deciduous trees or with moss. When leaf litter is moist, as occurs with rain, plethodontid salamanders forage away from moist retreats within talus (Feder 1983).

Ollivier et al. (2001) concluded there is a significant association of SMS with conditions found in later successional, undisturbed forests with a closed canopy and moist microclimate. These habitat attributes and rocky substrates dominated by cobble-sized pieces “appear optimal for reproductive success and long-term survival throughout the range of the species,” although overstory canopy ranged from 2.75 to 96.50% at occupied locations within California. Their conclusion is arguably consistent with their survey data. However, as described in Section 6.2 of this petition, DFG subsequently identified SMS, Scott Bar or Del Norte salamanders in 8 out of 13 precanopy sites where Ollivier et al. (2001) were

unsuccessful in determining occupancy. The data supporting their conclusion was therefore biased toward more densely forested sites and warrants reconsideration. Ollivier also reported that hardwoods were an important habitat component associated with the presence of SMS

After sampling all known SMS sites on Timber Products Company lands (n = 23), Farber et al. (2001, updated 2003) used a step-wise logistical regression of 25 independent habitat variables. Of these, only total percent rock was significant (R^2=0.17, df=21, P<0.05) in a model that predicted the abundance (dependent variable), of SMS. Other reviewers (i.e., Nauman 2004 pers. comm.; Welsh 2004 pers. comm.) are skeptical of the statistical validity of these findings. Similarly, Diller and Wallace (1994) found substrate was the primary factor predicting the presence of Del Norte salamanders, while slope, cover type and canopy cover were of secondary importance. Other studies indicated that hardwoods were an important habitat component associated with the presence of Del Norte salamanders (Raphael 1988; Welsh and Lind 1991; Welsh and Lind 1995). Bury et al. (1991) found that the strong association of *P. vehiculum* (western red-backed salamander) with talus or rocky soils may override other habitat relationships. They reported that occurrence and abundance of these salamanders were more likely to be related to the presence of rocky outcrops or underlying talus than to maturity of the forest stand.

Moisture in the litter and upper soil layers is important to lungless terrestrial salamanders. They require near constant contact with moist soil or litter so as to continuously maintain moist skin in order to respire. High relative humidity is required for surface activity, where the majority of feeding and mating is believed to occur. Even when salamanders are on the surface during high moisture conditions, they are at risk of dehydrating and must return to litter and subterranean refugia to rehydrate (Spotila 1971; Jaeger 1978).

Corn and Bury (1991) described three important surface microhabitats available to and heavily used by terrestrial salamanders: rocky substrates, downed wood, and leaf litter. The latter two microhabitats generally occur in greater amounts in unmanaged forests. However, Bury et al. (1991) stated that the occurrence and abundance of most species of woodland salamanders were more likely to be related to the presence of these microhabitats than to seral stage. For example, mid to late seral Douglas fir stands regenerated by catastrophic fires maintained microhabitat features despite the changes that occurred and plethodontid salamanders were found in all regenerated stands ranging from 55 to 750 years old (Aubry and Hall 1991). Fire has been a dominant force in shaping vegetative patterns, in natural regeneration, in arresting succession and in controlling stand density within the range of SMS. USFS forest inventory data for the Klamath National Forest (USDA Forest Service 1994b) suggest a historic average high intensity, stand-replacing fire frequency of 110-180 years in all forest types.

6.0 FACTORS AFFECTING ABILITY TO SURVIVE AND REPRODUCE

6.1 Studies of Salamander Response to Vegetative Disturbance

Since timber harvest disturbs more ground than any other land use in the known range of SMS, it is perceived to be the primary threat to SMS (Nussbaum 1974; California Department of Fish and Game 1987; Bury and Pearl 1999; USDA, USDI Species Review Panel 2001; Greenwald 2004). Timber operations may impact SMS directly when SMS are surface active during the spring and fall by killing animals during operations or indirectly by reducing habitat suitability. Harvesting removes tree and shrub canopy, which modifies the microhabitat at and potentially below the ground surface. Tractor operations can compact talus substrates, reducing habitat suitability, and may crush individual animals.

While several observational studies have shown persistence and reproduction of SMS following removal of forested stands (Farber et al. 2001; California Department of Fish & Game 2003; Klug 2003 pers. comm.), these results do not identify cause-and-effect relationships. The cause-and-effect response of SMS to removal of forested stands has not been critically examined and is unlikely to occur on private lands where the strict no-take requirements under CESA apply. Gravid SMS have been found in recent clearcuts (Farber et al. 2001) and open canopy forests (California Department of Fish and Game 2003).

A paired plot survey was conducted by the USFS for SMS near Elliott Creek in Siskiyou County; one site was clearcut in 1992 and a second location was selectively cut , i.e., one or two of the largest trees per acre were removed about 60 years ago (at Hutton Guard Station). In April 1993, a survey in the clearcut unit following harvest yielded 40 salamanders (10 salamanders per person hour). During single opportunistic searches conducted in the spring of 1994, 1995, 1998 and 1999, only one SMS was found (in 1999). The number of SMS found in the selectively cut site was relatively consistent (3-6 salamanders per person hour) during the years sampled (Clayton 2004a pers. comm.). Department staff surveyed this clearcut in the spring and fall of 2003 for SMS. In the spring, 3 salamanders (1 juvenile, 1 subadult and 1 adult[8]) were found by a single surveyor in 17 minutes and 5 salamanders (1 juvenile, 2 subadults and 2 adults) were found in the fall by a surveyor in 75 minutes.

Farber et al. (2001; updated 2004) examined historical records of natural or human disturbance at each occupied SMS site on Timber Products Company timberlands. Of 23 sites occupied by adults and juveniles, a total of 17 sites (73.9%) had varying intensities of either natural or human disturbance prior to surveys being conducted. Natural disturbance by windthrow had occurred at 2 sites (8.7%) and historic fire occurred at 2 sites (8.7%). Human disturbance by

[8] Life stage determination in the field was classified using snout-vent length (SVL) data in Ollivier and Welsh (2003) for Del Norte salamanders: juvenile SVL<28.45 mm/1.1 in., subadult SVL 28.45 mm/1.1 in. to 46.74 mm/1.8 in., adult SVL ≥ 46.75 mm/1.8 in.

either logging (selection silviculture) or mining occurred at 4 sites (17.3%). Disturbance by recent (post-1973) ground based tractor timber harvest had occurred at 9 sites (39.1%). Of the 23 occupied sites, 6 had multiple disturbances noted. Gravid females and juveniles were found within a clearcut area six years after ground-based harvesting and road construction. These activities had been approved before the range of SMS was known to include the specific location.

Fruit Growers Supply Company has monitored SMS on the Elliott Fly Timber Harvesting Plan (THP) #2-95-015(SIS), which was submitted in 1995 and completed in 1997. The silvicultural method was selection and all yarding was by helicopter. A conservation measure in the Biological Opinion for this THP (pursuant to FGC §2090) required the company to monitor the THP area and control sites to collect data regarding the effects of proposed operations on SMS and its habitat. Monitoring data for 2005 has recently been provided to the Department for analysis. In prior years on 10 study plots within harvest units that contained SMS, SMS were found postharvest at 9 plots in 1998 and 8 plots in 2002. Adult, subadult and juvenile SMS have been found, indicating that the animals have continued to occupy most of the sites and appear to be reproducing. In one plot, where no animals were detected preharvest, subsequent searches in 1998 and 2002 yielded two and five animals (including one subadult), respectively. Only three plots were surveyed in 2003 and no SMS were found (Klug 2003 pers. comm.; Bull pers. obs.).

Several studies of the closely related Del Norte salamander demonstrated higher abundances in mature forests (Raphael 1988; Welsh and Lind 1991; Welsh and Lind 1995), although Diller and Wallace (1994) found no relationship between forest age and Del Norte presence in road-cut talus habitats. These results may be due to climatic differences within the species' range between the interior (Welsh and Lind 1991 and 1995) and coastal (Diller and Wallace 1994) areas.

Green Diamond (formerly Simpson) Resource Company is conducting an ongoing study to quantify the numerical response of Del Norte salamanders to clearcut timber harvest of occupied sites. Data have been collected since 1993 on 10 control-treatment plots. To date, Del Norte salamanders have not been extirpated from any site due to harvesting activities and all life stages have been found. Of 699 adult salamanders sampled, the proportion of gravid females in the clearcuts and undisturbed control sites was 12.7% and 11.4%, respectively (Diller 2003 pers. comm.). The data have not been statistically analyzed, but no strong change in population structure is apparent from inspection of the data (Diller 2004 pers. comm.). The most interior (i.e. inland) site had the fewest salamanders. In a paired plot survey for Del Norte salamanders conducted by Redwood Sciences Laboratory from 1987 to 1999 on one clearcut versus one old-growth plot, no gravid females were detected in the clearcut (Welsh 2003 pers. comm.).

Other coastal Pacific Northwest species of the genus *Plethodon* have been studied with regard to the effects of forest management. In a control-treatment study in western Washington, Grialou et al. (2000) found western red-backed salamanders (including gravid females) in clearcut and thinning treatments. Although animals were found, their capture rates were reduced postharvest. Grialou et al. (2000) reported that soil compaction due to timber harvesting may have rendered the soil column more difficult for salamanders to access. Soil compaction and decreased leaf litter cover in the clearcut areas may have interacted with other factors to reduce abundance (Grialou, et al., 2000). Although SMS may be less abundant in clearcuts, the full representation of size classes and presence of gravid females in clearcuts suggest to the Department that SMS are reproducing and persisting. Corn and Bury (1991) found no significant difference in relative abundance of western red-backed salamanders between clearcuts and old-growth in Oregon.

In a study in Canada on western red-backed salamanders, abundance was three to six times higher in old-growth (>330 years) than in managed stands (Dupuis 1995). Cole et al. (1997) sampled western red-backed salamanders in deciduous red alder sites in the Oregon Coast Range. Average capture rates were highly variable from year to year, but capture rates increased significantly during the first year after clearcut logging. After two years, the capture rates decreased to preharvest levels.

The response of plethodontid salamanders to the harvest of forested stands on talus slopes has not been comprehensively studied. Individual animals may simply move underground, reducing the chance of capture during surveys targeting surface active animals (deMaynadier et al.1995). Taub (1961) and Bailey et al. (2004) found that 2 to 32% of the total number of salamanders, in suitable habitat, is available at any one time for capture near the surface. The abundance of plethodontid salamanders may be reduced by timber management activities. However, plethodontid salamanders, including reproductive females, have been documented after timber management disturbances.

More information is available about the effects on plethodontid salamanders of timber harvesting in the eastern United States. While all plethodontid salamanders are lungless, they do not necessarily have the same life histories or habitat requirements. In the eastern United States, summer rains are common and most of these studies have been done on the effects of timber harvesting in deciduous forests. A summary of some of the studies conducted on these eastern plethodontid salamanders is presented below. It is a common wildlife management practice to consider information from related species where it is available. However, caution must be used in the interpretation of these results when applied to comparisons with SMS because other salamander species may not respond in exactly the same way and their habitats are not identical.

Research conducted on eastern plethodontid salamanders (non-talus, deciduous

forest dwelling species) has found that ground based logging, with various silviculture treatments (including clearcuts), reduces salamander abundance, but does not eliminate those species from occupied sites. Red-backed salamanders in New York deciduous forests were less abundant in clearcuts than adjacent old-growth, but the numbers of salamanders found in 60-year old second-growth forests were the same as in the old-growth forest (Pough et al. 1987). Petranka et al. (1993) found five times more salamanders in mature forests than on recent clearcuts (<10 years old) in western North Carolina. At low elevation sites in the southern Appalachians, fewer salamanders were found in clearcuts less than 5 years old than in mature stands (Petranka et al. 1994). Ash (1997) studied the effect of clearcut logging on plethodontid habitat in the southern Appalachians and found that relative abundance was decreased significantly, but salamanders were still present at the site. Herbeck and Larsen (1998) also found lower densities of plethodontid salamanders in clearcuts than in late seral forests in the Missouri Ozark forests. Red-backed salamanders were the most sensitive amphibian in a study on the effects of clearcut edges, with lower abundances in clearcuts and forest edges (deMaydenair and Hunter 1998).

Messere and Ducey (1998) studied abundance of plethodontid salamanders following timber harvest in central New York and found no significant difference in abundance of salamanders in forest canopy gaps (selection silviculture), forest edge, and forest stands. The abundance of western red-backed salamanders, three years after different silvicultural treatments, decreased significantly in group selection, shelterwood removal, leave tree and a clearcut, but not in the understory removal (Harpole and Haas 1999). In western North Carolina, Harper and Guynn (1999) found that salamander densities were lowest in young (<12 years old) stands. Densities were equal in stands 13-39 years and stands ≥ 40 years old. Duguay and Wood (2002) found lower numbers of plethodontid salamanders in two-age treatments than mature second-growth, but not lower in the clearcut than mature second-growth treatment. Knapp et al. (2003) found an overall decrease in abundance of all salamander species, but no significant difference between the short-term effects of clearcut treatments and other silvicultural treatments.

These studies in the eastern United States show that, in most cases, populations of plethodontid salamanders declined immediately following timber harvesting activities. The time required for populations to return to predisturbance levels after clearcutting of deciduous forests in the eastern United States was estimated to be 20-24 years (Ash 1997), 21.5 years (Harper and Guynn 1999) and 50-70 years (Petranka et al. 1993). Duguay and Wood (2002) found results that were consistent with Ash (1997).

6.2 California Department of Fish and Game 2003 Field Studies

In 2003, Department biologists attempted to visit as many known SMS sites as possible. The objective was to document habitat elements, substrate, and

disturbance. Ninety-two sites previously documented as occupied by SMS were inspected. This field study was designed to be as comprehensive as possible and presents data from every location known at the time on Fruit Growers Supply Company and Timber Products Company private timberlands and every site on Federal lands which Department staff could precisely locate. The majority (87%) of these sites were on private lands. The results cannot be used to statistically assess species preference, but do illustrate the range of variability of habitat conditions where SMS occur.

The following observations were made at the sampled sites:

- All aspects were represented[9].
- Sixty-two percent of the sites occurred on slopes of 50% or greater.
- The majority (16 of 18) of the California Wildlife Habitat Relationships (CWHR) tree size and canopy classes[10] were represented on the 1/10 acre sites.
- Conifers dominated the basal area at most sites. Hardwoods provided some or most of the cover at a total of 56 sites, and of those, 29 sites were classified as either Montane Hardwood/Conifer or Montane Hardwood.
- The percent cover of rock >2.54 cm (1 inch) covering each plot was estimated at 50% or more at 56 sites.
- In each instance, the cover object where the first animal was detected was a cobble or boulder sized rock. Cobble and/or boulder-sized rock were visually estimated to be 35% of the rock surface cover at the 92 sites. Cobble and/or boulder-sized rock were present at all but one site.
- Evidence of timber harvest (i.e., tree stumps) was observed at 42 sites. Multiple types of disturbance[11] were observed at 36 sites. No evidence of disturbance was found at 20 sites.
- Moderate (10- 50%) and high (>50%) basal area removal was estimated at 45% and 29% of the 92 sites, respectively.
- Soil disturbance was 50% or greater at more than one-third (37%) of the sites.

The Department also attempted to locate the precanopy (defined as a clearcut or forest stand less than 30 years old) sites where Ollivier et al. (2001) did not detect SMS, to conduct opportunistic surveys[12]. Using the data provided (Ollivier et al. 2001), 13 of 17 precanopy sites in California[13] were located in 2003. Plots

[9] Aspect (# sites): North (35), East (13), South (18), West (26)
[10] CWHR size classes represented (#sites): 1(11), 2S(9), 2P(7), 2M(1), 3S(10), 3P(11), 3M(6), 3D(7), 4S(2), 4P(2), 4M(8), 4D(8), 5S(4), 5P(1), 5M(1), 6(4)
[11] Types of disturbance recorded: landslide, fire, timber harvest, skid trail, road, mining
[12] Funding for Ollivier et al. (2001) was provided in part by the Department under contract FG 6508 R1. Detection of this species is difficult and the knowledge that species experts have not always been able to find SMS during optimal conditions at known localities (Olson 1999) prompted this effort.
[13] Ollivier et al. (2001) separates their analysis of California and Oregon sites but chose to add data from sites located within California north of the Siskiyou Crest into their data set for Oregon

sampled by Ollivier et al. (2001) were found at nine sites (consisting of survey flagging and/or a stake was found). At the other four sites where the exact plot could not be located, the stand was searched for suitable rock substrate and surveyed. SMS were detected by the Department at 7 of the 13 sites (2 locations are now known to support Scott Bar salamanders) and Del Norte salamanders occupied another site. All life stages[14] of SMS or Scott Bar salamanders were detected at 5 of the 7 occupied sites. A gravid female was found on an undisturbed precanopy plot, an indication that reproduction may occur even without dense canopy forest conditions.

Appendix A to this petition includes the following:

1) An example data sheet with instructions used by the Department for this survey work
2) Graphic representations of the data presented above
3) Photographs of the 8 precanopy sites where Ollivier et al. (2001) did not find salamanders and where Department staff were able to document presence of either SMS, Scott Bar or Del Norte salamanders.
4) Two data summary tables representing results of Department surveys of the 8 precanopy sites where salamanders were found.

In any survey there is a chance that SMS will not be detected, even where they do exist. These "false negative", or "Type I[15]" errors occur for various reasons, one of which includes microclimate conditions forcing SMS to be further underground at the particular time of the survey than inspection techniques can detect. Another factor can be the experience level of the surveyor, simply not searching for a long enough period of time or searching less carefully in locations which the surveyor believes to be suboptimal. Later surveys under more suitable locations or by more experienced surveyors may find SMS in the same exact location.

On the basis of correlative data, collected during surveys which do not meet current protocols for determining absence, Ollivier et al. (2001), conclude that SMS are linked with conditions found more consistently in later seral forests. However, Ollivier et al. (2001), failed to detect SMS, Scott Bar or Del Norte salamanders in precanopy sites (both disturbed and undisturbed) where surveys by the Department later documented presence. Ollivier et al. (2001) incorrectly rejected the hypothesis that SMS occupied at least 7 of 13 precanopy and

---

sites. In this petition, where the Department characterizes the California sites visited by Olliver et al. (2001) we use the actual state boundary to separate the sites.

[14] Life stage determination in the field was verified by snout-vent length (SVL) data in Ollivier and Welsh (2003) for Del Norte salamanders: juvenile SVL<28.45 mm/1.1 in., subadult SVL 28.45 mm/1.1 in. to 46.74 mm/1.8 in., adult SVL ≥ 46.75 mm/1.8 in.

[15] A "Type I" error means that a true hypothesis (e.g. salamanders are present on a particular site) is incorrectly rejected and is more serious than a "Type II" error which means that a false hypothesis is not rejected.

disturbed sites. This systematic Type I error fundamentally compromises their data analysis and conclusions regarding both microhabitat and macrohabitat requirements for the species. The conclusions presented in Ollivier et al. (2001) that SMS are more consistently found in late seral forests are, at best, marginally supported by their data analysis. If Ollivier et al. (2001) had detected SMS in their "precanopy" study sites where the Department subsequently documented SMS presence; their results would likely not have supported their conclusions. Further, one of the precanopy sites (#91) selected by Ollivier et al. (2001), is considered by the Department to be unsuitable for Plethodon salamanders due to the presence of only a single layer of rock. It is possible that SMS were also present in additional late seral sites but were not detected during surveys by Ollivier et al. (2001). This probability does not contradict the Department's conclusion that SMS occupy a wide range of sites, including both disturbed and undisturbed sites with low canopy cover.

Three surveys of habitat (Olson 1999) under strict environmental conditions are necessary to determine that a site is not occupied, as discussed above. The protocols were not developed until after Ollivier et al. (2001) collected the majority of their data using a less intensive protocol.

6.3 Other Disturbances Potentially Affecting SMS

Fire, road building, quarry development, and recreational developments may also impact the species. Most prehistoric fires were probably low intensity, frequent and occurred when the animals were not active near the surface, with little consequence for SMS. USFS forest inventory data for the Klamath National Forest (USDA Forest Service 1994b) suggest a historic average high intensity, stand-replacing fire frequency of 110-180 years in all forest types. Recent fire suppression has made the landscape more prone to high intensity, stand replacing fire events (USDA Forest Service 1994b) that could impact the species, although Del Norte salamanders were found to persist in areas that had burned under moderate to high severity, at one, two and more than ten years following wildfire events (West 2004 pers. comm.). Another potential threat to the species is prescribed fire when conducted during the times of the year when salamanders may be active near the surface.

Available information indicates that SMS are found in areas with various levels of disturbance. SMS are known to occur within disturbed sites, such as rock quarries, log landings, and road and skid road cutbanks and fill-slopes. Due to ease of capture, many animals have been collected from talus banks of road cuts. SMS may colonize road cuts soon after road construction, moving in from talus above and below the road (Nussbaum 1974), move into the road cut only during the wet season (Nauman 2004 pers. comm.) or, more likely, were already on site (Welsh 2004 pers. comm.). Both adult and juvenile animals have been found in road cuts, quarries and mined areas (Farber 2004c pers. comm.; Klug 2003 pers. comm.).

No information is available for this species regarding predation, competition or disease.

7.0 DEGREE AND IMMEDIACY OF THREAT

7.1 Problem Statement

SMS was listed as rare in California based on the limited distribution at the time, while current information shows it to be more widespread. At the time of listing, this species was thought to primarily inhabit stabilized talus in old-growth forest stands with northern exposures, though it is now known to inhabit talus in a wide range of habitat types and aspects. SMS were thought to be extirpated by intensive land management, although unpublished information presented to the Department over the past ten years by private timberland owners indicated otherwise. This new information was an impetus for the Department to review status of the species.

Recent developments in ecology include the concept of naturally occurring "metapopulations." One useful definition for a metapopulation is a "…group of subpopulations with movement between the groups much less than movement within them" (Simberloff, 1988). Wildlife populations are rarely, if ever, dispersed in an even manner across the landscape. Instead, wildlife occurs in spatially discrete distributions where suitable habitat is present and there is a non-trivial probability of extinction for one or more discrete populations (McCullough 1996). This is true for SMS and many other wildlife species (e.g., pikas, marmots).

Habitat for SMS is naturally fragmented across the landscape in locations where suitable rocky talus substrate is present. At issue is whether natural (e.g., fire) or anthropogenic disturbances (e.g., timber harvesting, road construction, and mining) further fragment the landscape and extirpate populations of SMS.

The petition proposing Federal listing of SMS identifies climate change (i.e., global warming) as a concern and partial justification for protection under the Federal ESA. The petition hypothesizes that global warming may lead to less opportunity for SMS to forage and reproduce. Further, since SMS exhibit low vagility[16], the species is unlikely to simply relocate to more suitable habitat as the climate warms.

7.2 Analysis

SMS inhabit talus slopes and move vertically through the substrate as microhabitat conditions change. Conflicting information available to the Department represented that 1) SMS are significantly associated with conditions

[16] "Vagility" means the capacity or tendency of an organism to move about or disperse in a given environment.

found in later successional, undisturbed forests with a closed canopy (Ollivier et al. 2001) versus, 2) SMS are also found within disturbed sites, such as timber harvest units, rock quarries, log landings, and road and skid trail cutbanks and fill-slopes (Farber et al. 2001; Farber et al 2002b; Klug 2003 pers. comm.). Timber harvest results in greater ground disturbance than any other land use in the known range of SMS and it is perceived to be the primary threat to SMS. Field studies were conducted by the Department to characterize habitat conditions and document disturbance at as many known locations as possible. In 2003, the Department visited 92 sites where SMS have been found. These field studies documented habitat conditions and disturbance on each 1/10 acre plot with plot center where the first SMS was detected. Of these 92 sites, 78% had been disturbed by a landslide, fire, timber harvest, skid trail, road and/or mining. Timber harvesting has occurred on 47% of the plots and 39% had two or more disturbances. Opportunistic surveys by the Department detected SMS in talus with little or no overstory that had been clearcut, burned or had no disturbance. These observations weaken assertions that SMS require conditions found in later successional, undisturbed forests with a closed canopy.

In the future, 24% (10% private and 14% Federal matrix) of the lands within the currently documented range could be subjected to intensive timber harvesting, while the remainder are projected to have limited management under current Klamath National Forest management plans. Analysis of disturbance over the range of SMS in California shows that at least 37% of the landscape has been disturbed by fire or timber harvesting, yet SMS continue to be found in these areas and are reproducing. Talus and forested rocky substrate are likely the most important environmental factors affecting SMS, and though common, these habitats have a patchy distribution throughout the known range. SMS occupies a wide range of forest types with a varied range of overstory canopy cover and can be found on all slope aspects.

“Metapopulation models have largely replaced island biogeography as the theoretical framework for thinking about fragmentation issues” (Wiens 1996). Theory predicts that species fitting a metapopulation model (like SMS) will tend to persist relative to other species which are not subdivided into spatially discrete local populations (Simberloff, 1988). Persistence of species increases with the number of subpopulations (Simberloff, 1988) and the landscape scale (i.e., range) over which the species is distributed (Wiens, 1996). The original concept of metapopulation theory is credited to Levins (1970) and his model included three critical elements which were: density dependence in local population dynamics, spatial asynchrony in local population dynamics and limited dispersal linking the local populations (Wiens 1996).

Regarding the first element, there are little data available describing behavioral interactions between salamanders, or emigration from local populations. Generally, SMS are believed to exhibit low vagility (Greenwald, 2004) and documented movements for a closely related species are for relatively short

distances (Welsh 1992; Lowe 2001). According to Welsh (2003 pers. comm.) however, *Plethodon* salamanders are territorial (a density dependent population dynamic) and this leads to dispersal of juveniles away from the local population.

Dynamics of local SMS populations are likely to be asynchronous with other populations. Disturbances which may kill individual animals or impact local habitat suitability, such as road building, fire, timber harvesting or mining will ordinarily not affect disjunct populations. Metapopulation theory predicts that this characteristic is likely to increase persistence of a species on larger landscapes (Wiens 1996).

A potential exception to the above pertains to the risk of global warming. Any adverse effects of global warming would likely affect many, perhaps all, subpopulations at the same time (i.e., synchronous rather than asynchronous). The U.S. Environmental Protection Agency (2004) cites the National Academy of Sciences in reporting that "[T]he Earth's surface temperature has risen by about 1 degree Fahrenheit in the past century, with accelerated warming during the past two decades." The consequences of this trend could include an increase in the average global surface temperature of 1-4.5 degrees Fahrenheit in the next fifty years. Predicted environmental consequences of this include changes in the geographic range of forests, increases in the frequency of fire and insect outbreaks, changes in the carbon storage function of forests, increased precipitation and changes in weather patterns (Intergovernmental Panel on Climate Change 2001). These predictions are generalized and not certain to apply in any specific geographic region.

The subterranean microenvironment in which SMS spend most of their time is less sensitive to temperature changes than aboveground environments. Changes in vegetation types aboveground, rainfall and fire frequency likely pose risks to SMS by altering elements of the current habitat conditions. Potential effect mechanisms include canopy modification which changes temperature at the soil surface, changes in the rates of organic input to the talus habitat and changes in the associated animal community which depends upon these organic inputs.

A relevant consideration is that SMS have likely occupied the Klamath-Siskiyou bioregion for at least three to four million years (Pfrender and Titus 2001). This region was not subject to extensive volcanic or glacial activity during either the Pliocene or Holocene epochs which would otherwise have impacted distributions of plants and animals. The Pliocene epoch, beginning about five million years ago and ending about one and one-half million years ago, was initially warmer than current conditions and began cooling about two and three quarter million years ago. "Relative to today, the Pliocene warm period was characterized by ~ 3°C higher global surface temperatures, 10-20 m higher sea level, enhanced thermohaline circulation, slightly reduced Antarctic ice sheets, emerging but small North American ice coverage, and slightly (30%) higher atmospheric

carbon dioxide concentrations" (Ravelo et al. 2004). While postulated warmer conditions several decades hence will not be identical to early Pliocene conditions, SMS apparently have behavioral and physiological adaptations which have allowed them to persist, so far, through a wide range of conditions, including circumstances similar to those which may occur if the environment becomes warmer.

The USFWS considered and made five determinations in considering whether emergency listing of SMS under the Federal ESA was warranted (USDI Fish and Wildlife Service, 2004). These threat factors were:

- present or threatened destruction, modification, or curtailment of habitat and range,
- overutilization for commercial, recreational, scientific, or educational purposes,
- disease or predation,
- inadequacy of existing regulatory mechanisms,
- other natural or manmade factors affecting their continued existence.

The USFWS determined that, while threats do exist from private and Federal land management activities, such threats do not constitute an imminent threat warranting emergency listing. This finding does not prevent the USFWS from reconsidering this matter and reaching a different decision in the future. However, the USFWS is continuing to evaluate the population status and habitat associations of SMS, and will evaluate Candidate Species status following review (Woodbridge 2005a and b pers. comm.).

Wildfire is a factor worth considering as a risk. USFS forest inventory data for the Klamath National Forest (USDA Forest Service 1994b) suggest a historic average high intensity, stand-replacing fire frequency of 110-180 years in all forest types. Wildfires occur more frequently during warm dry conditions when SMS are unlikely to be at the surface and direct mortality is likely infrequent. The potential loss of tree canopy and organic debris on the soil surface by burning may modify the talus microclimate and interrupt the supply of organic material serving as an energy source for prey organisms. Several decades of fire suppression have likely augmented fuel loading which increase the intensity of fire when it occurs. In this landscape where high intensity stand-replacing fires occurred on a frequency of 110-180 years, SMS have persisted for a very long time, conservatively 3 to 4 million years. No data is available documenting exactly how long SMS have occupied any specific location within their range. Assuming low vagility for the species and long persistence in the Klamath-Siskiyou bioregion, intense stand replacing fires and less intense, more frequent anthropogenic fires to reduce fuel loading appear to pose little risk to species viability.

7.3 Risk Characterization

Observations of current occupancy by SMS at disturbed sites indicate that some level of disturbance is likely tolerated by populations of SMS. There are at least four possible interpretations for these observations:

1) suitability of the disturbed habitat is reduced to the extent that the local population gradually declines and becomes extirpated;

2) populations are reduced or extirpated by the disturbance and then supplemented or replaced by other animals migrating into the habitat as it recovers;

3) populations persist but surface activity is reduced;

4) populations are initially reduced but recover over time.

Alternatives 1 and 2 are less likely than alternatives 3 and 4. Juveniles and gravid females were found at multiple disturbed sites (some 100-plus yards from closed canopy forests), which indicates that SMS were reproducing within disturbed sites. If alternative 1 or 2 were occurring, most or all of the animals on disturbed sites should be non-reproductive adults. SMS have low vagility (Welsh 2004 pers. comm.; Greenwald 2004), and coupled with the very limited time these animals are active above ground, makes it unlikely that juveniles (recent hatchlings < 28.5 mm/1.1 in. SVL) migrate long distances[17] into disturbed areas.

Alternatives 3 and 4 are more likely than alternatives 1 and 2. Populations of SMS most likely decrease following timber harvesting, either through direct or indirect mortality, as shown with other plethodontid salamanders. Generally, fewer SMS are captured in recently disturbed sites than habitat which is either undisturbed or substantially recovered from disturbance. Without mark/recapture studies to attempt to determine population sizes and evaluate effects of timber harvesting this will remain unverified. Prohibitions on take, and the issuance criteria required for an incidental take permit, currently make such studies impractical.

Current land management practices, including intensive forestry, likely have adverse site-specific impacts on individual animals and local populations. Individual animals may be killed and local populations may be reduced in size. Observations of all age classes on disturbed sites suggest that the scenario of local populations being extirpated is not likely though it may occur in the smallest, most isolated populations. The current known distribution of the species, presence of all age classes, and the range-wide history of logging, fires, road building and mining suggests the species can recover from local disturbances

[17] Based upon available information for *P. elongatus*, 50 meters would be an extraordinarily long movement (Welsh and Lind 1992; Lowe 2001).

without affecting persistence of local populations occupying isolated habitat. Full recovery from significant disturbance may require several decades.

The current risk of extinction for this species is negligible. SMS populations will likely survive and reproduce within the known range even where resource management activities, including timber harvesting, mining, fuel reduction by prescribed burning and road building, are performed.

8.0 IMPACTS OF EXISTING MANAGEMENT EFFORTS

Approximately 90% of the current known range of SMS in California occurs on Federal lands, with the remaining 10% falling on privately owned lands (Table 1). Of the sites currently known to support SMS, 68% occur on Federal lands and 32% occur on private lands. Due to non-random survey effort this may not reflect the actual distribution of animals and the proportional relationship of land ownership within the known range may not be correlated with the distribution of habitat.

The primary federal land allocations include (USDA and USDI 1994):

(1) Administratively Withdrawn Areas are identified in current forest and district plans or draft plan preferred alternatives and include recreational and visual areas, back country, and other areas not scheduled for timber harvest. Administratively withdrawn areas are unregulated lands which do not have a regular programmed timber harvest and are not managed to provide timber outputs, although non-scheduled or incidental harvest might be obtained if they serve to enhance other resources.

(2) Congressionally Reserved Areas are lands that have been reserved by act of Congress for specific land allocation purposes. Included in this category are National Parks and Monuments, Wilderness Areas, Wild and Scenic Rivers, National Wildlife Refuges, Department of Defense lands, and other lands with congressional designations.

(3) Late-Successional Reserves (LSR) are to be managed to protect and enhance old-growth forest conditions. For each late-successional reserve (or group of small reserves) managers should prepare an assessment of existing conditions and appropriate activities. No programmed timber harvest is allowed inside the reserves. However, thinning or other silvicultural treatments inside these reserves may occur in stands up to 80 years of age if the treatments are beneficial to the creation and maintenance of late-successional forest conditions. In the reserves east of the Cascades and in Oregon and California Klamath Provinces, additional management activities are allowed to reduce risks of large-scale disturbance. Salvage guidelines are intended to prevent negative effects on late-successional

habitat. Non-silvicultural activities within late-successional reserves are allowed where such activities are neutral or beneficial to the creation and maintenance of late-successional habitat. Thinning or other silvicultural activities must be reviewed by the Regional Ecosystem Office and the Regional Interagency Executive Committee.

(4) Matrix lands are where most timber harvest will occur. Standards and guidelines assure appropriate conservation of ecosystems as well as provide habitat for rare and lesser-known species. Some of the major standards and guidelines for matrix lands are: a renewable supply of large down logs must be in place; at least 15 percent of the green trees on each regeneration harvest unit located on National Forest land must be retained (except within the Oregon Coast Range and Olympic Peninsula provinces); and 100 acres of late-successional habitat around owl activity centers that were known as of January 1, 1994, must be protected.

Private lands within the range of SMS in California are primarily timberlands and will likely continue to be managed for timber production.

Table1. Ownership and land management plan (LMP) type within the range of SMS in California.

Ownership	LMP Type	LMP Land Allocation	% within SMS Range	% of SMS Sites
Federal	Withdrawn	Administratively Withdrawn	23%	23%
		Congressionally Reserved Areas	9%	1%
		LSRs	44%	33%
	Matrix	Scenic River Retention Recreational River Partial Retention General Forest	14%	11%
Private			10%	32%

8.1 Federal Lands

Under the Northwest Forest Plan, in the 1994 Record of Decision, the Bureau of Land Management (BLM) and USFS adopted standards and guidelines for the management of habitat for late-successional and late seral forest-related species within the range of the northern spotted owl. Specific standards and guidelines, called “Survey and Manage,” addressed concerns for the persistence of rare and endemic species by providing for management of known sites, site-specific pre-

habitat-disturbing surveys, and/or landscape scale surveys for about 400 rare and/or uncommon species. SMS were included in the list of Survey and Manage Species. Protection included no entry into occupied habitat and a one tree height (100-160 foot) buffer around the habitat. In accordance with the Northwest Forest Plan, LSRs, Congressionally Reserved Areas and Administratively Withdrawn areas are to be maintained as late-successional habitat over the next 100 years, maintaining suitable talus habitat for SMS. The USFS expects suitable habitat for SMS within matrix lands to be modified in the immediate future (USDA, USDI Species Review Panel 2001). Based upon surveys in 2003, *Plethodon sp.* may be less abundant in withdrawn lands, despite designation as late successional and riparian reserves, and more abundant in matrix lands (Nauman and Olson 2004). This relationship was observed even in riparian reserves adjacent to matrix lands. Nauman and Olson (2004) suggest these results may be driven by generally higher elevations in late successional reserves or biases created by differences in rainfall patterns. This rationale does not explain why SMS appear to be more abundant in matrix lands than in riparian reserves adjacent to matrix lands. However, the sample size was small (N = 9) and might not be conclusive.

In the Federal 2001 Survey and Manage annual species review for SMS, the panel of specialists and managers from the BLM, USFS, USFWS, and the Pacific Northwest Research Station compiled existing information and determined that further pre-disturbance surveys would not be necessary north of the Siskiyou Crest, because of the large number of known sites already protected in the northern range (including Oregon). It was determined that the level of rarity of SMS would not be affected by discontinuing pre-disturbance surveys or by the loss of some undiscovered sites. High priority sites for this species would continue to be managed to provide suitable habitat for SMS. High priority sites, generally, will be those needed to maintain well-distributed populations across the known range of the species on Federal lands and to avoid a trend towards listing under the Federal ESA. Approximately 110 such sites have been identified so far (Clayton 2004b pers. comm.). Whereas protection was decreased to the north, the Federal panel decided that no change in protection of the species was warranted south of the Siskiyou Crest. High-priority sites would continue to be identified through surveys and managed to provide for reasonable assurance of species persistence south of the crest. Until high-priority sites were identified, all known sites were to be managed south of the Siskiyou Crest.

Effective April 21, 2004, the Survey and Manage standards and guidelines were removed from the Northwest Forest Plan; SMS subsequently were added to the USFS Sensitive Species List. The objectives of the Sensitive Species policies include maintaining viable populations in habitats on National Forest System lands and ensuring that actions do not contribute to the need to list under the Federal ESA (USDA, USDI 2004). This program does not have a process to improve knowledge of the species.

If the Commission decides to remove SMS from the list of State Threatened species, the USFS, BLM and USFWS will likely take that action into account as these agencies make their respective future decisions regarding treatment as a sensitive species or listing under the Federal ESA. Though the outcome of such consideration cannot be predicted it is worth noting that State listing as Threatened or Endangered is not a prerequisite for USFS or BLM listing as Sensitive. For example, Del Norte and Southern Torrent salamanders are both listed as Sensitive species by the USFS though neither is State listed as Threatened or Endangered. Federal (i.e., USFS) lands account for 90% of the currently known range in California and almost all activities which can disturb SMS habitat on Federal lands are not subject to any of the requirements of CESA, including the prohibition on take. The principal application of the Commission's decision in this matter will apply to 10% of the currently known range.

In June 2004, a petition was filed for SMS to be emergency listed as threatened or endangered under the Federal ESA (Greenwald 2004). The petitioners cite the elimination of the Survey and Manage Program and its associated protection of SMS and its habitats as the main reason for filing. The 30-day finding for this petition from the USFWS concluded that there is no imminent threat to the species that would warrant an emergency listing (USDI Fish and Wildlife Service 2004).

8.2 Private Lands

For private timberlands, portions of the California Environmental Quality Act apply to the review of proposed THPs. Additional requirements established in the Forest Practice Rules (14 CCR 895 *et seq.*) also apply so that THPs are the functional equivalent of Environmental Impact Reports. THPs are submitted to the California Department of Forestry and Fire Protection (CDF). When the THP is within the range of SMS, CDF requires consultation with the Department. Pursuant to FGC section 2080, take of SMS is prohibited. Incidental take may be authorized pursuant to FGC 2081. However, for SMS, incidental take has generally been limited to permits for scientific, educational or management purposes (FGC §2081(a)). One exception was incidental take authorized for the Elliot Fly THP (THP #2-95-015-SIS) under former FGC §2090.

To assure compliance with FGC §2080, and based upon current information about SMS, the Department considers all suitable habitat (rocky/talus patches covering at least 25% of the surface area) within the known range of SMS to be occupied unless surveys, conducted according to protocol, indicate otherwise. When potentially suitable habitat is present within a proposed THP, the project proponent consults with the Department. In this process the Department specifies measures necessary to avoid incidental take. These measures include prohibitions on timber harvesting operations where SMS or suitable habitat is present. Buffer zones are established around the habitat (15m/50feet or

30.5m/100 feet, depending on silvicultural methods) where heavy equipment is excluded and canopy must be maintained at or above the canopy present within the habitat areas. To avoid take of SMS in buffer zones, restrictions limit operations to dry, hot periods when SMS are not active near the surface of the ground. This is because SMS usually are active near the surface in the spring and fall, when temperatures are low and humidity is high. SMS retreat below the surface into talus when conditions are not suitable. If SMS are observed at or near the surface anywhere in the THP area when conditions are otherwise being met to conduct operations, the operations halt immediately and do not resume without first consulting the Department. These measures protect and maintain suitable habitat.

9.0 SUGGESTIONS FOR FUTURE MANAGEMENT

Available information indicates that SMS is not likely to become endangered in the foreseeable future and is not in serious danger of becoming extinct throughout all or a significant portion of its range. The Department has considered whether designation of SMS as a California Species of Special Concern is warranted, absent listing as Threatened, and concluded the criteria for such listing are not met. The Department further believes that no special management provisions or protections under the CEQA or Forest Practice Rules are necessary to conserve this species.

The Department proposes to enter into an initial five year program in collaboration with private forest landowners to document and report on the response of SMS to timber operations. At, or before, the conclusion of this effort the Department may elect to extend the work further in time if necessary to document longer term response by SMS to disturbance.

10.0 SOURCES OF INFORMATION

A. Literature

i. Ash, A.N. 1997. Disappearance and return of Plethodontid salamanders to clearcut plots in the southern Blue Ridge Mountains. Conservation Biology 11:983-989.

ii. Aubry, K.B. and P.A. Hall. 1991. Terrestrial amphibian communities in the southern Washington Cascade range. Pages 327-340 in L.F. Ruggiero, K.B. Aubry, A.B. Carey and M.H. Huff, technical coordinators. Wildlife and vegetation of unmanaged Douglas-fir forests. General technical report PNW-GTR-285. U.S. Forest Service, Pacific Northwest Research Station, Portland, OR.

iii. Bailey, L.L., T.R. Simons, and K.H. Pollock. 2004. Estimating detection probability parameters for Plethodon salamanders using the robust capture-recapture design. Journal of Wildlife Management 68(1):1-13.

iv. Brodie, E.D., Jr. 1970. Western salamanders of the genus Plethodon: systematics and geographic variation. Herpetologica 26:468-516.

v. Bury, R.B. 1973. Western Plethodon: systematics and biogeographic relationships of the Elongatus group (Abstract). HISS News-Journal 1:56-57.

vi. Bury, R.B. 1998. Evolution and zoogeography of the Del Norte and Siskiyou Mountains salamander with management recommendations. Unpubl. Final Report to U.S. Fish and Wildlife Service and Bureau of Land Management, Medford, District. USGS Forest and Rangeland Ecosystem Science Center.

vii. Bury, R.B. and C.A. Pearl. 1999. Klamath-Siskiyou Herpetofauna: Biogeographic Patterns and Conservation Strategies. Natural Areas Journal 19:341-350.

viii. Bury, R.B., P.S. Corn, and K.B. Aubry. 1991. Regional patterns of terrestrial amphibian communities in Washington and Oregon. Pages 341-350 in L.F. Ruggiero, K.B. Aubry, A.B. Carey and M.H. Huff, technical coordinators. Wildlife and vegetation of unmanaged Douglas-fir forests. General technical report PNW-GTR-285. U.S. Forest Service, Pacific Northwest Research Station, Portland, OR.

ix. California Department of Fish and Game. 1987. Five year status report, Siskiyou Mountains salamander. Inland Fisheries Division. Endangered Species Project.

x. California Department of Fish and Game. 2003. 2003 Siskiyou Mountains Salamander Surveys and Site Descriptions. Unpublished data.

xi. Clayton, D.R., L.M. Ollivier, and H.H. Welsh, Jr. 1999. Survey protocol for the Siskiyou Mountains salamander (Plethodon stormi), ver. 3.0 Pp. 125-162 In: D.H. Olson (ed.), Survey protocols for amphibians under the Survey and Manage provision of the Northwest Forest Plan. Interagency publication of the Regional Ecosystem Office, Portland, OR. BLM Publ. BLM/OR/WA/PT-00/033+1792, US GPO: 2000-589-124/04022 Region No. 10, 310p.

xii. Cole, E.C., W.C. McComb, M. Newton, C.L. Chambers, and J.P. Leeming. 1997. Response of amphibians to clearcutting, burning, and glyphosate application in the Oregon coast range. Journal of Wildlife Management 61(3):656-664.

xiii. Corn, P.S. and R.B. Bury. 1991. Terrestrial amphibian communities in the Oregon Coast Range. Pages 305-318 in L.F. Ruggiero, K.B. Aubry, A.B. Carey and M.H. Huff, technical coordinators. Wildlife and vegetation of unmanaged Douglas-fir forests. General technical report PNW-GTR-285. U.S. Forest Service, Pacific Northwest Research Station, Portland, OR.

xiv. DeGross. D.J. 2004. Gene flow and the relationship of the salamanders *Plethodon stormi* and *P. elongatus* assessed with 11 novel microsatellite loci. Master of Science thesis, Oregon State University.

xv. deMaynadier, P.G. and M.L. Hunter, Jr. 1995. The relationship between forest management and amphibian ecology: a review of the literature. Environmental Reviews 3:230-261.

xvi. deMaynadier, P.G. and M.L. Hunter, Jr. 1998. Effects of silvicultural edges on the distribution and abundance of amphibians in Maine. Conservation Biology 12(2):340-352.

xvii. Diller, L.V. and R.L. Wallace. 1994. Distribution and habitat of Plethodon elongatus on managed, young growth forests in north coastal California. Journal of Herpetology 28(3):310-318.

xviii. Duguay, J.P. and P.B. Wood. 2002. Salamander abundance in regenerating forest stands on the Monongahela National Forest, West Virginia. Forest Science 48(2):331-335.

xix. Dupuis, L.A., J.N. Smith, and F. Bunnell. 1995. Relation of terrestrial-breeding amphibian abundance to tree-stand age. Conservation Biology 9(3):645-653.

xx. Farber, S., R. Hawkins, and J. Whitaker. 2001. Habitat Relationships of Siskiyou Mountains salamander (*Plethodon stormi*) on Timber Products Forestlands in Northern California. Prepared for: The California Department of Fish and Game during their status review of the Siskiyou Mountains salamander. Yreka, CA.

xxi. Farber, S., S. Criss and D. Criss. 2002a. Field Guide for Siskiyou Mountains salamander (*Plethodon stormi*) and other woodland

salamanders located in Siskiyou County, California. Yreka, CA.

xxii. Farber, S., R. Hawkins, and J. Whitaker. 2002b. Supplemental Information for: Habitat Relationships of Siskiyou Mountains salamander (*Plethodon stormi*) on Timber Products Forestlands in Northern California. Prepared for: The California Department of Fish and Game during their status review of the Siskiyou Mountains salamander. Yreka, CA.

xxiii. Feder, M.E. 1983. Integrating the ecology and physiology of plethodontid salamanders. Herpetologica 39(3):291-310.

xxiv. Fish and Game Code. 2003. California Edition. Law Tech Publishing.

xxv. Greenwald, D.N. 2004. Petition to list the Siskiyou Mountains salamander (*Plethodon stormi and asupaki*) (*sic*) as threatened or endangered under the Endangered Species Act. Submitted to the U.S. Fish and Wildlife Service on June 16, 2004.

xxvi. Grialou, J.A., S.D. West, and R.N. Wilkens. 2000. The effects of forest clearcut harvesting and thinning on terrestrial salamanders. Journal of Wildlife Management 64(1):105-113.

xxvii. Grover, M.C. 1998. Influence of cover and moisture on abundances of the terrestrial salamanders *Plethodon cinereus* and *Plethodon glutinosus*. Journal of Herpetology 32(4):489-497.

xxviii. Harper, C.A. and D.C. Guynn, Jr. 1999. Factors affecting salamander density and distribution within four forest types in the southern Appalachian Mountains. Forest Ecology and Management 114:245-252.

xxix. Harpole, D.N. and C.A. Haas. 1999. Effects of seven silvicultural treatments on terrestrial salamanders. Forest Ecology and Management 114:349-356.

xxx. Hedrick, P.A. 1996. Genetics of metapopulations: Aspects of a comprehensive perspective. In: McCullough D.R., editor. Metapopulations and Wildlife Conservation, Island Press, Covelo, CA.

xxxi. Herbeck, L.A. and D.R. Larsen. 1998. Plethodontid salamander response to silvicultural practices in Missouri Ozark forests. Conservation Biology 13(3):623-632.

xxxii. Herrington, R.E. 1988. Talus use by amphibians and reptiles in the Pacific Northwest. In: Szaro, R.C., Severson, K.E. and Patton, D.R., eds. 1988. Management of amphibians, reptiles, and small mammals in North America. Gen. Tech. Rep RM-166. Ft. Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station:.216-221.

xxxiii. Highton, R. and A.H. Brame. 1965. *Plethodon stormi* species nov. Amphibia: Urodela: Plethodontidae. Pilot Register of Zoology Card No. 20.

xxxiv. Intergovernmental Panel on Climate Change, 2001. Climate Change 2001. Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. [White, K.S., Q.K. Ahmad, O. Anisimov, N. Arneil, S. Brown, M. Campos, T. Carter, C. Liu, S. Cohen, P. Desanker, D.J. Dokken, W. Easterling, B. Fitzharris, H. Gitay, A. Githeko, S. Gupta, H. Harasawa, B.P. Jallow, Z.W. Kundzewicz, E.L. La Rovere, M. Lal, N. Leary, C. Magadza, D. Murdiyarso, L.A. Nurse, C. Parmesan, M.L. Parry, O. Pilifosova, B. Pittock, J. Price, T. Root, C. Rosenzweig, J. Sarukhan, H.J. Schnellnhuber, S. Schneider, M.J. Scott, G. Sem, B. Smit, J.B. Smith, A. Tsyban, P. Vellinga, R. Warrick, D. Wratt. M. Manning and C. Nobre (eds.)]. <http://www.ipcc.ch/ > Accessed December 28, 2004.

xxxv. Jaeger, R.G. 1978. Plant climbing by salamanders: periodic availability of plant-dwelling prey. Copeia 1978:686-691.

xxxvi. Kesner, W.D. 1977. The Siskiyou Mountain salamander-Biology, habitat requirements, distribution, interim management direction, and research needs. USDA Forest Service. Klamath National Forest.

xxxvii. Knapp, S.M., C.A. Haas, D.N. Harpole, and R.L. Kirkpatrick. 2003. Initial effects of clearcutting and alternative silvicultural practices on terrestrial salamander abundance. Conservation Biology 17(3):752-762.

xxxviii. Leonard, W.P., H.A. Brown, L.L.C. Jones, K.R. McAllister, and R.M. Storm. 1993. Amphibians of Washington and Oregon. Seattle, WA: Seattle Audubon Society.

xxxix. Levins, R. 1970. Extinction. In M. Gerstenhabe, ed. Some Mathematical Questions in Biology. Pp. 77-107. Providence, R.E. American Mathematical Society.

xl. Lowe, Jason. 2001. Population structure and habitat relationships of sympatric populations of the terrestrial salamanders *Plethodon elongatus* and *Ensatina eschscholtzii* before a prescribed fire. Masters thesis, Humboldt State University.

xli. Mahoney, M.J. 2001. Molecular systematics of *Plethodon* and *Aneides* (Caudata: Plethodontidae: Plethodontini): phylogenetic analysis of an old and rapid radiation. Molecular Phylogenetics and Evolution 18:174-188.

xlii. Mahoney, M.J. 2004. Molecular systematics and phylogeography of the Plethodon elongatus species group: combining phylogenetic and population genetic methods to investigate species history. Molecular Ecology 13:149-166.

xliii. Mayer, K.E. and W.F. Laudenslayer. 1988. A guide to wildlife habitats of California. California Department of Forestry and Fire Protection.

xliv. McCullough, D. R. 1996. Introduction in McCullough D.R. editor. Metapopulations and Wildlife Conservation. , Island Press, Covelo, CA.

xlv. Mead, L.S., D.L. Clayton, R.S. Nauman, D.H. Olson, and M.E. Pfrender. 2005 Newly discovered populations of salamanders from Siskiyou County California represent a species distinct from *Plethodon stormi*. Herpetologica 61(2): 158-177.

xlvi. Messere, M. and P.K. Ducey. 1998. Forest floor distribution of northern redback salamanders, *Plethodon cinereus*, in relation to canopy gaps: first year following selective logging. Forest Ecology and Management 107:319-324.

xlvii. Murphy, D.D. and B.D. Noon. 1991. Coping with uncertainty in wildlife biology. J. Wildl. Manage. 55(4):773-782.

xlviii. National Research Council. 1995. Science and the Endangered Species Act. National Academy Press. Washington D.C. 271 pp.

xlix. Nauman, R.S. and D.H. Olson. 2004. Strategic survey annual report, Siskiyou Mountains salamander, southern population. USDA Forest Service, PNW Research Station, Corvallis, OR.

l. Nussbaum, R.A. 1974. The distributional ecology and life history of the Siskiyou Mountains salamander, *Plethodon stormi*, in relation to the potential impact of the proposed Applegate Reservoir on this species. Unpublished report submitted to the Army Corps of Engineers, Portland Division, Portland, OR. 70p.

li. Nussbaum, R.A., E.D. Brodie, Jr., and R.M. Storm. 1983. Amphibians and reptiles of the Pacific Northwest. University of Idaho Press, Moscow, ID.

lii. Ollivier, L.M., H.H. Welsh, Jr., and D.R. Clayton. 2001. Habitat Correlates of the Siskiyou Mountains Salamander, *Plethodon stormi* (Caudata: Plethodontidae); with Comments on the Species' Range. USDA Forest Service, Redwood Sciences Lab, Arcata, CA.

liii. Ollivier, L. and H.H. Welsh, Jr. 2003. Determining sex and life stage of Del Norte salamanders from external cues. Northwestern Naturalist 84:129-134.

liv. Olson, D.H. 1999. Standardized survey protocols for amphibians under the survey and manage and protection buffer provisions, ver. 3.0 Pp. 125-162 In: D.H. Olson (ed.), Survey protocols for amphibians under the Survey and Manage provision of the Northwest Forest Plan. Interagency publication of the Regional Ecosystem Office, Portland, OR. BLM Publ. BLM/OR/WA/PT-00/033+1792, US GPO: 2000-589-124/04022 Region No. 10, 310p.

lv. Petranka, J.W., M.E. Eldridge, and K.E. Haley. 1993. Effects of timber harvesting on southern Appalachian salamanders. Conservation Biology 7(2):363-370.
lvi. Petranka, J.W., M.P. Brannon, M.E. Hopey, and C.K. Smith. 1994. Effects of timber harvesting on low elevation populations of southern Appalachian salamanders. Forest Ecology and Management 67:135-147.
lvii. Pidwirny, M. 2004. Fundamentals of physical geography. http://www.physicalgeography.net/fundamentals/3b.html. Accessed January 28, 2005.
lviii. Pfrender, M.E. and T. Titus. 2001. Genetic structure, biogeographic patterns, and founder events in the Siskiyou Mountains salamander (*Plethodon stormi*). Report submitted to the USDA Forest Service.
lix. Pough, F.H., E.M. Smith, D.H. Rhodes, and A. Collazo. 1987. The abundance of salamanders in forest stands with different histories of disturbance. Forest Ecology and Management 20:1-9.
lx. Raphael, M.G. 1988. Long-term trends in abundance of amphibians, reptiles, and mammals in Douglas-fir forests of northwestern California. *In* Management of amphibians, reptiles, and mammals in North America. *Edited by* R.C. Szaro, K.E. Severson, and D.R. Patton. USDA Forest Service General Technical Report RM-166, pp. 23-31.
lxi. Ravelo, A.C., D. H. Andreasen, M. Lyly, A.O. Lyle, and M.W. Wara. 2004. Regional climate shifts caused by gradual global cooling in the Pliocene epoch. Nature 429:263-267.
lxii. Simberloff, D. 1988. The contribution of population and community biology to conservation science. Ann. Rev. Ecol. Syst. 19:473-511.
lxiii. Spotila, J.R. 1971. Role of temperature and water in the ecology of lungless salamanders. Ecological Monographs 42(1)95-125.
lxiv. Stebbins, R.C. 1985. Peterson Field Guides: Western reptiles and amphibians. Boston, MA.
lxv. Taub, F.B. 1961. The distribution of the red-backed salamander, *Plethodon c. cinereus*, within the soil. Ecology 42:681-698.
lxvi. USDA Forest Service, USDI Bureau of Land Management. 1994. Record of Decision: for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl. 74p
lxvii. USDA, USDI Species Review Panel. 2001. 2001 Species review process step 2 worksheet. (In depth analysis). Reviewers David Clayton, Dede Olson, Steve Morey, Brenda Devlin, Hartwell Welsh, Richard Nauman, Charlie Crisafulli. US Department of Agriculture Forest Service and U.S.

Department of Interior Bureau of Land Management. April 27, 2001.

lxviii. USDA, USDI Species Review Panel. 2002. 2002 Survey and manage step 2 worksheet. Reviewers Steve Morey, Dave Clayton, John Guetterman, Dede Olson, Richard Nauman, Ed Reilly, and Hart Welsh. US Department of Agriculture Forest Service and U.S. Department of Interior Bureau of Land Management. May 13, 2002.

lxix. USDA, USDI. 2004. Final supplemental environmental impact statement to remove or modify the survey and manage mitigation measure standards and guidelines. U.U. Department of Agriculture Forest Service and U.S. Department of Interior Bureau of Land Management. January 2004.

lxx. USDA Forest Service. 1994a. Land and Resource Management Plan. Klamath National Forest. Siskiyou County, CA and Jackson County, OR.

lxxi. USDA Forest Service. 1994b. Final Environmental Impact Statement. Klamath National Forest. Siskiyou County, CA and Jackson County, OR.

lxxii. USDI Fish and Wildlife Service. 2004. Siskiyou Mountains salamander petition emergency finding. July 17, 2004.

lxxiii. U.S. Environmental Protection Agency. 2005. Global Warming Web Site.http://yosemite.epa.gov/oar/globalwarming.nsf/content/climate.html. Accessed January 4, 2005.

lxxiv. Wake, D.B. 1997. Incipient species formation in salamanders of the *Ensatina* complex. Proc. Natl. Adad. Sci. 94:7761-7767.

lxxv. Wake, D.B. and E.L. Jokusch. 2000. In: Bruce et al. editors. The Biology of Plethodontid Salamanders, Kluwer Academic/Plenum Publishers, New York.

lxxvi. Wiens, J.A. 1996. Wildlife in Patchy Environments: Metapopulations, Mosaics and Management. In: Metapopulations and Wildlife Conservation, Island Press, Covelo, CA.

lxxvii. Welsh, H.H., Jr. and A.J. Lind. 1991. The structure of the herpetofaunal assemblage of the Douglas-fir forests of Northwestern California and Southwestern Oregon. Pages 394-413 in L.F. Ruggiero, K.B. Aubry, A.B. Carey and M.H. Huff, technical coordinators. Wildlife and vegetation of unmanaged Douglas-fir forests. General technical report PNW-GTR-285. U.S. Forest Service, Pacific Northwest Research Station, Portland, OR.

lxxviii. Welsh, H.H., Jr. and A.J. Lind. 1992. Population ecology of two relictual salamanders from the Klamath Mountains of northwestern California. Pages 419-437 in D.R. McCulloch

and R.H. Barrett, editors. Wildlife 2001: populations. Elsevier Science, London.

lxxix. Welsh, H.H., Jr. and A.J. Lind. 1995. Habitat correlates of the Del Norte salamander, *Plethodon elongatus* (Caudata: Plethodontidae), in northwestern California. Journal of Herpetology 29(2):198-210.

B. Personal Communications

i. Bull, Jennifer. Field inspections of the Elliot Fly THP postharvest monitoring. Department of Fish and Game. 26 March. 2003.

ii. Clayton, Dave. “Re: Hutton Guard Station.” E-mail to Jennifer Bull. 24 June. 2004a.

iii. Clayton, Dave. “Re: SMS-High priority sites.” E-mail to Jennifer Bull. 30 December. 2004b.

iv. Clayton, Dave. “Status of Siskiyou Mtns. Salamander delisting petition.” E-mail to Mark Stopher. 30 June. 2005.

v. Cuenca, Sam. “Comments to draft”. E-mail to Jennifer Bull. “Comments on Siskiyou Mountain Salamander Draft Species Status Review.” 11 May. 2004.

vi. Diller, Lowell. “RE: Del Norte data.” E-mail to Jennifer Bull. “Draft Response of Del Norte salamanders (Plethodon elongatus) to clearcut timber harvest in coastal Northern California.” 22 November. 2003.

vii. Diller, Lowell. “RE: Del Norte data.” E-mail to Jennifer Bull. 24 November. 2004.

viii. Farber, Stu. Biologist for Timber Products Company. [Letter to Jennifer Bull, Environmental Scientist, Department of Fish and Game. “Additional information request for SMS”]. 6 October. 2003c.

ix. Farber, Stu. “SMS Gravid Females.” E-mail to Jennifer Bull. 4 December. 2003a.

x. Farber, Stu. “RE: SMS Gravid Females.” E-mail to Jennifer Bull. 19 December. 2003b.

xi. Farber, Stu. [Letter to Mark Stopher, Department of Fish and Game, Habitat Conservation Program Manager. “RE: Comments on the Draft Status Review for the Siskiyou Mountains salamander”]. 10 April. 2004a.

xii. Farber, Stu. “Re: Scott Bar PL sp. sites.” E-mail to Dave Clayton. 14 May. 2004b.

xiii. Farber, Stu. [Letter to Jennifer Bull, Environmental Scientist, Department of Fish and Game. “Additional information request for site disturbance records.” 15 July. 2004c.

xiv. Klug, Rich. Telephone interviews by Jennifer Bull. Fall 2003.

xv. Nauman, Richard, Dave Clayton and Dede Olson. Amphibian Taxa Team. [Letter to Mark Stopher, Department of Fish and Game,

Habitat Conservation Program Manager. “Comments on draft status review for Plethodon stormi”]. 2 April. 2004.

xvi. Olson, Deanna. Research Ecologist. Pacific Northwest Research Station, U.S. Forest Service. [Letter to Mark Stopher, Department of Fish and Game, Habitat Conservation Planning Branch, Chief]. 27 June. 2005.

xvii. Wake, David. Professor of the Graduate School, UC Berkeley. [Letter to Mark Stopher, Department of Fish and Game, Habitat Conservation Program Manager]. 22 May. 2004a.

xviii. Wake, David. ”Re: Siskiyou Mtns Salamander comments.” E-mail to Mark Stopher. 4 August. 2004c.

xix. Wake, David. “Re: SMS Genetics.” E-mail to Jennifer Bull. 25 July. 2004b.

xx. Wake, David. Professor of the Graduate School, UC Berkeley. [Letter to Mark Stopher, Habitat Conservation Planning Branch, Chief]. 5 July. 2005.

xxi. Welsh, Hartwell. Research Ecologist for US Forest Service, Redwood Sciences Laboratory. [Letter to Mark Stopher, Department of Fish and Game, Habitat Conservation Program Manager]. 27 August. 2003.

xxii. Welsh, Hartwell. Research Ecologist and Don Ashton, Ecologist, for US Forest Service, Redwood Sciences Laboratory. [Letter to Mark Stopher, Department of Fish and Game, Habitat Conservation Program Manager. “Comments on California Department of Fish and Game’s DRAFT Status Review of Siskiyou Mountains salamander, *Plethodon stormi”*]. 20 May. 2004.

xxiii. Welsh, Hartwell. . Research Wildlife Biologist for US Forest Service, Redwood Sciences Laboratory. [Letter to Mark Stopher, Habitat Conservation Planning Branch, Chief]. 29 July. 2005.

xxiv. West, Karen. “My comments.” E-mail to Jennifer Bull. “Comments prepared for California Department of Fish and Game re: DRAFT status Review, Siskiyou Mountains salamander (*Plethodon stormi*).” 11 May. 2004.

xxv. Woodbridge, Brian. Telephone interview by Jennifer Bull. 1 February. 2005a.

xxvi. Woodbridge, Brian. "Re: Quick question- SMS." E-mail to Jennifer Bull. 7 February. 2005b.

C. Contact Information

i. Bull, Jennifer. Department of Fish and Game. 303 South Street, Yreka, CA 96097. 530.842.0805.

ii. Clayton, Dave. USDA Forest Service. Rogue-Siskiyou National Forest. 333 West 8th Street, Medford, OR 97501. 541.858.2276.

iii. Cuenca, Sam. USDA Forest Service. Klamath National Forest, Scott River Ranger District. 1312 Fairlane Road, Yreka, CA 96097. 530.468.5351.

iv. Diller, Lowell. Green Diamond Resource Company. P.O. Box 68, Korbel, CA 95550. 707.668.3709.

v. Farber Stu. Timber Products Company. P.O. Box 766. Yreka, CA 96097. 530.842.2310.

vi. Klug, Rich. Roseburg Forest Products. 98 Mill, Weed, CA 96094. 530.938.5729. Formerly of Fruit Growers Supply Company.

vii. Mead, Louise. The Shaffer Lab. Section of Evolution & Ecology. University of California, Davis. One Shields Avenue, Davis, CA 95616. 530.752.2939.

viii. Nauman, Richard and Dede Olson. USDA Forest Service. Pacific Northwest Research Station. 3200 SW Jefferson Way, Corvallis, OR 97331. 541.750.7250.

ix. Wake, David. University of California, Berkeley. Museum of Vertebrate Zoology. 3101 Valley Life Science Building #3160, Berkeley, CA 94720. 510.642.3567.

x. Welsh, Hartwell and Don Ashton. USDA Forest Service. Pacific Southwest Research Station. Redwood Sciences Laboratory. 1700 Bayview Drive, Arcata, CA 95521. 707.825.2956.

xi. West, Karen. USDA Forest Service. Klamath National Forest. 1312 Fairlane Road, Yreka, CA 96097. 530.842.6131.

xii. Woodbridge, Brian. US Fish and Wildlife Service. 1833 S. Oregon Street. Yreka, CA 96097. 530.842.5763.